# HOUSE OF REPRESENTATIVES

# HEARINGS

## BEFORE THE COMMITTEE

## on

SELECT COMMITTEE ON ASSASSINATIONS

ASSASSINATION OF PRESIDENT JOHN F. KENNEDY

Washington, D. C.

Monday, September 11, 1978

Official Reporters to Committees

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ASSASSINATION OF PRESIDENT JOHN F. KENNEDY

Monday, September 11, 1978

House of Representatives,

Select Committee on Assassinations,

Washington, D.C.

The select committee met, pursuant to adjournment, at 9:10 a.m., in Room 345, Cannon House Office Building, Louis Stokes (chairman of the select committee) presiding.

Present: Representatives Stokes, Devine, Preyer, McKinney, Sawyer, Dodd, Ford, Fithian, and Edgar.

The Chairman. A quoroum being present, the committee will come to order.

At the outset of this morning's hearings I would like to make some brief remarks.

This morning, the Select Committee on Assassinations begins it second week of public hearings into the death of President John F. Kennedy. The evidence to be heard today will be directed toward the number, direction and timing of the shots fired at President Kennedy in Dealey Plaza on November 22, 1963.

Much of the evidence heard last week by the committee tended to support the basic conclusions of the Warren Commission, which concluded that Lee Harvey Oswald was the lone assassin of the President.

The evidence to be heard today will be troubling to some. I would caution against those who would too quickly draw sensational conclusions from this evidence.

Mr. Justice Holmes used to say that the first requirement of a good theory was that it fit the facts.

Since all of the evidence in the Kennedy investigation is not in, it is not yet possible to fit any theory to the facts. A final resolution of the questions that may be raised by today's evidence must, therefore, await the conclusion of our hearings and the submission of our final report in December.

Mrs. Benson. Mr. Chairman, my name is Mildred Benson. I am from Pittsburgh.

The Kennedy assassinations--

The Chairman. Madam, you are disturbing a congressional hearing and that will not be tolerated.

Madam, I will have to ask you to leave the hearings.

Mrs. Benson. These were political conspiracies. My family and I have been subjected to a savage program----

The Chairman. Will the Capitol Police see that this woman is removed from the hearings?

Mrs. Benson. John Kennedy and Robert Kennedy were killed by political conspiracy.

The Chairman. The Chair recognizes Professor Blakey.

## STATEMENT OF G. ROBERT BLAKEY, CHIEF COUNSEL

Mr. Blakey Thank you, Mr. Chairman.

Three days of testimony before the committee--both firsthand and expert in character--have indicated that a number of crucial issues in the Kennedy assassination turn on questions relating to the shots fired by the assassin or assassins.

How many were fired?

What was the time span between them?

From what direction were they fired?

Put succinctly: resolving the question of the number of those who participated in the assassination itself--a lone assassin or more than one gunman, that is, a conspiracy--may well hinge on the number of shots fired, the time interval between them, and the direction from which they were fired.

As we have seen, the Warren Commission was persuaded there were at least two shots--more probably three--and they all came from the Texas School Book Depository, which was to the right rear of the Presidential limousine. The commission found the discovery of three spent cartridge cases on the floor of the sixth story of the book depository its most persuasive evidence on the question of the number of shots, even though the medical and ballistics evidence could account for only two shots.

Based on expert FBI testimony that the minimum time required to fire the rifle ranged from 2.25 to 2.3 seconds and an anlysis of the Zapruder film, it also concluded that the time from the first to the last shot most probably ranged from 7.1 to 7.9 seconds.

The best way, of course, to determine the number of shots is to listen to them--either when they occur or subsequently--on a sound recording, if one were to exist. The Warren Commision was alerted to the possibility of such a recording, one that was made by Dallas radio station KBOX and later used as part of a phonograph record produced by Colpix, Inc., ''Four Days that Shocked the World.'' A private citizen who had bought the record informed the commission on January 8, 1964 about the program and suggested that sounds of shots could be detected in an on-the-scene account of the assassination by Dallas reporter Sam Pate.

The commission obtained the recording from KBOX, and on June 29 Assistant Counsel Arlen Specter wrote a memo to General Counsel J. Lee Rankin in which he noted, ''Several members of the staff listened to the tape and heard two noises which sound like gunshots...''

On June 30, the commission sent the tape to Dr. Lawrence Kersta of Bell Telephone Laboratories, Murray Hill, New Jersey. Dr. Kersta's analyses of the tape, however, were apparently inconclusive. I say ''apparently,'' because attempts by this committe to find reports of Dr. Kersta's work have been to date unsuccessful.

Another way to try and pin down the number, time sequence and direction of the shots is to take testimony from on-the-scene witnesses. The Warren Commission conduced--or had conducted for it--exhaustive interviews of this character.

The recollections of the witnesses, however, were far from consistent. On the number of shots, the range was from two to six, although three was seemingly the consensus. The time sequence ranged from 5 to 6 seconds.

On their origin, reactions were also mixed. Many witnesses thought they came from the general direction of the book depository, but a significant number of others put the firing point at a piece of elevated landscape to the front and right of the limousine that has come to be known as the ''grassy knoll.''

Many witnesses frankly confessed confusion. For example, Abraham Zapruder, who stood on a concrete abutment in front of the grassy knoll and took his widely viewed movie of the assassination, said that he thought it came ''from back of me,'' but that there was ''too much reverberation'' to tell for sure.

In any event, it seems clear that any serious effort to explain or understand what happened in Dealey Plaza must take into account all of the firsthand evidence on number, time and direction--even when it is apparently in conflict.

On the other hand, some of the testimony relating to the direction of the shots was based on more than a reaction to the bark of a rifle. Howard L. Brennan, for example, said he actually ''saw a man fire one shot'' from the depository. James Jarman, who was on the fifth floor of the depository, also said he heard the sound of the bolt action of a rifle and the cartridge cases dropping to the floor above him.

Neverthless, many critics have alleged that the commission, in the ultimate analysis, forced the evidence on the question of number and direction into a mold consistent with the discovery of the three cartridge cases on the sixth floor of the book depository.

Mark Lane, for example, argues that this was how the single bullet theory came into being. In his ''Rush to Judgement,'' Lane writes the commission ''...salvaged its basic working hypothesis (the lone assassin theory) by concluding that the bullet that struck Governor Connally first struck the President.''

Josiah Thompson, in his ''Six Seconds in Dallas,'' did a statistical analysis of the statements of the witnesses to the shots. His findings support the commission on the number of shots but dispute it on the direction from which they came: 84.4 percent of them heard three shots, Thompson found, but of those who had an opinion as to direction, 52 percent thought they came from the grassy knoll, 39 percent from the direction of the depository.

Inevitably, of course, the select committee has had to attempt to unravel these conflicting views. Fortunately, it has had the aid of modern technology. New scientific methods have been applied to old evidence in some cases; in other cases, it has analyzed important pieces of new evidence that had previously been overlooked. For one example, the committee devised new tests for the Zapruder film, an original piece of evidence. For another, the committee asked a consultant to perform advanced computer studies with new evidence, a sound recording of the assassination itself that has been only recently turned up.

The photographic experiments were conducted by the committee's photographic panel of experts. They involved attempts to analyze camera ''jiggle'' in an effort to record what well might have been startled reactions to gunshot wounds.

The thought was that Zapruder may have reflexively moved his camera when he heard each shot. By measuring the intensity of blurs on given frames, it was hoped that the timing of the shots could be indirectly pinpointed.

Dr. WIlliam Hartmann was in charge of what has come to be known on the staff as the ''jiggle analysis.'' Dr. Hartmann received a B.S. degree in physics from Pennsylvania University in 1961, an M.S. degree in geology from the University of Arizona in 1965 and Ph.D. degree in astronomy from the University of Arizona in 1966. He has been assistant professor at the University of Arizona Lunar and Planetary Laboratory, associate and senior scientist at the IIT Research Institute and currently is senior scientist at the Planetary Science Institute of Scientific Applications, Inc.

Dr. Hartmann is a member of the American Astronomical Society and is the co-winner of the 1965-66 Ninniger Meterorite Award. He has written numerous professional articles and has served as associate editor of the Journal of Geophysical Research. He has authored a planetary textbook and co-authored a book on the planet Mars.

Dr. Hartmann served as photo analyst and co-investigator on the Mariner 9 mission to photograph Mars.

It would be appropriate at this time, Mr. Chairman, to call Dr. Hartmann.

The Chairman. The committee calls Dr. Hartmann.

Sir, will you raise your right hand to be sworn?

Do you solemnly swear that the testimony you will give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Dr. Hartmann. I do.

The Chairman. Thank you.

You may be seated.

The Chair recognizes Counsel Gary Cornwell.

Mr. Cornwell. Thank you, Mr. Chairman.

Dr. Hartmann, as a member of the photo panel, did you conduct photographic analysis in order to determine if there was any measurable reaction on the part of photographers who were taking pictures in Dealey Plaza at the time of the assassination which might be associated with the sound of gunfire?

TESTIMONY OF WILLIAM HARTMANN

Dr. Hartmann. Yes.

Mr. Cornwell. What theoretical reason or justification would there be for conducting that type of analysis?

Dr. Hartmann. I think there are several possible justifications for it that add together.

First, psychological experiments have shown that there is a rather universal startle reaction, and interestingly enough, the classic work on this published in 1939 used gunshots before unsuspecting witnesses as the source of the stimulus to cause the startle reaction.

Secondly, using a motion picture camera such, as Mr. Zapruder's camera and his film, is an ideal test for startle reaction, because the photographer is attempting to hold this camera still or pan very smoothly, so that any startle reaction would cause a disturbance of that smooth panic motion.

Third, then there would be a question was the stimulus, the gunfire in Dealey Plaza, loud enough to cause such a startle reaction.

I was present on August 20 when the committee did some test firing with the rifle similar to the one believed to have been used, and I found, first of all, that this was a very loud noise, louder than I had suspected, and in fact I attempted to take some pictures simultaneously with the gunfire and found that in three out of three cases my pictures were blurred when they were taken with gunfire and not when they were taken with other times.

In fact I think my pictures were probably more blurred, showed a larger startle reaction than Mr. Zapruder's.

Finally, it is a reasonable investigation to undertake because we know that there are some episodes of blur in the Zapruder film as you watch it.

Mr. Cornwell. When did you first undertake this analysis?

Dr. Hartmann. It was proposed in February, but we did not undertake it until July when it began to be apparent to the committee that there might be data from the acoustic analysis with which we could compare it, so that we would have some independent information to compare with.

Mr. Cornwell. Who did you work with in the analysis?

Dr. Hartmann. Frank Scott, who is a photo scientist at Perkin Elmer, and Elmer was also a member of the photo panel, and he did independent set of measurements on the same film.

Mr. Cornwell. Did the procedures which were selected, were they followed both by you and Mr. Scott, the same procedures?

Dr. Hartmann. No. We used separate procedures. We both made a series of measurements on the film, but each decided for himself what system might be best to record in a quantitative way these blurs or jiggles.

Mr. Cornwell. Just very briefly, would you tell us what the differences were between the two approaches that you took?

Dr. Hartmann. Briefly, I measured the amount of blur or smearing of the image in each frame of the film, one frame at a time, and what Mr. Scott did was to follow from one frame to the next the position of the camera, where it was pointed in the landscape, and to see how smooth that tracking was between one frame and the next frame.

Mr. Cornwell. So then would it be accurate to state that you measured the blur internally within the frame and Mr. Scott measured the blur which occurred between two frames?

Dr. Hartmann. Yes, in a real sense mine is a measure of the blur while the shutter was open, and Mr. Scott's is a measure of the blur that occurred from the middle of the time the shutter was open on one frame to the time it was open on the next frame.

Mr. Cornwell. I would like to show you Exhibits F-224, 225, 226, and 227, which I believe have been previously admitted in this case.

The photographs correspond to Frames 188 to 191 of the Zapruder film. I ask you if you would use those exhibits to illustrate first the technique which you applied.

Dr. Hartmann. Yes. May I go over to the board?

Now this is Frames 188 through 191 in order and it is a good example of what can be done. These are enlargements of part of the frame, but here you see a reasonably sharp frame, a rather typical frame, and there are some highlights on the car which appear as circular or slightly elliptical bright spots. So these are the smallest things that you can resolve, the smallest spots that you can see in the picture.

On this frame, you may be able to see that the spots are a little elongated in this direction, meaning that while the shutter was open, the camera moved a little bit in that direction.

Now the camera is moving considerably more violently during the exposure, and we have an elongation in this direction, And here, finally, Frame 191, which is quite seriously blurred and is in fact one of the more blurred frames in the sequence. So the length of these spots can be measured from frame to frame, and that gives a measurement of what we call the blur or the jiggle.

Mr. Cornwell. So it would be possible then, I take it, to quantify the amount of blur or jiggle in the frame.

Dr. Hartmann. Yes, by direct measurement of the length of this blurred spot, and that, in essence, is a measurement of the error in the photographer's accuracy in panning on the Presidential car that went by.

Mr. Cornwell. I would like to show you Exhibit F-175 and ask you if you can identify that.

Dr. Hartmann. Yes. This is a plot of the amount of blur that we measured by the technique I used on each frame.

Mr. Cornwell. Mr. Chairman, at this time I would request that that exhibit be admitted into evidence.

The Chairman. Without objection, it may be entered into the record at this point.

[The information follows:]

*********** COMMITTEE INSERT **********

Mr. Cornwell. Would you explain, Dr. Hartmann, what that exhibit illustrates or what it shows?

Dr. Hartmann. Yes. I tried to plot the amount of blur. So the amount of blur is plotted in this vertical direction and it is expressed here in terms of the percent of the width of the field so that a blur right along here of this magnitude is about 1 percent of the width of the field. Up here it is about 6 percent of the width of the field.

These are the frame numbers. This is a running count of the time in seconds. I chose to use zero at about Frames 310 to 311 because that would be the moment in essencehen the man pulled the trigger on the gun. The bullet is seen to strike the head in 313, or the head is seen to explode at that time, so zero can be considered one known gunshot time.

Now each dot is a frame. And if you asked for a threshold and said are there any blurs greater than 6 percent, let's say, well, there would be none. And if you start to lower your threshold, coming down to about 4 percent, we start to pick up a blur. This one is Frame 330, and as we come on down, we pick up more blurs.

Well, of course, if you go too low, you are getting into basically noise, just the ordinary jiggle, and we don't want to clutter up our analysis with looking at the ordinary jiggle. So I arbitrarily chose a threshold, and to make it a little bit clearer, drew a line here, and any jiggles or blurs or errors in panning would stick up above that line then are outlined with solid lines to make them clearer. So there are some patterns, clusters of jiggles, which may be response to some sort of stimulus.

Mr. Cornwell. I would like to ask you, if you could use the blackboard now which is behind you, and illustrate for us, if you would, Mr. Scott's analysis.

Dr. Hartmann. Yes. He reasoned as follows: Suppose the car is coming by and the photographer is following the car precisely. He would be aiming his camera at the middle of each exposure as the shutter opens and closes and opens and closes at a series of points which would be arranged in a nice smooth line and relatively equally spaced.

Now if any stimulus or any cause made him jiggle the camera or jerk the camera, we would have this pattern of regular pointing spots going on, and then perhaps, let's say, the camera moves in a downward direction. And so in the first case, we would have a line of points like that, but in the second case, a line like this, and this would betray an irregularity in the panning on the Presidential car.

Mr. Cornwell. I would like to show you now Exhibits F-371, 372 and 373, and ask you if you would tell us what those are.

Dr. Hartmann. I might just comment also, as that is being set up, that a way to express this measurement quantitatively in a similar fashion to the other diagram would be to say that at this particular frame the photographer should move, in the next frame, he should move to this position, but in fact we discover that he has moved down here, so that this distance is a measure of the error. So it is possible to convert these into a set of quantitative measurements of the error. This is essentially a method known as vector subtraction between these two lines.

These are, first, an explanation of his method and enlargement of one sequence of frames in the fashion that he measured them and his entire sequence of measurements.

Mr. Cornwell. So referring to Exhibit F-373, that is, the entire sequence of the frames in the Zapruder film beginning at what point and ending at what other point.

Dr. Hartmann. Yes. These run from in the 130s, when the Presidential motorcade comes around the corner, all the way to the 390s, when it disappears.

Mr. Cornwell. Would it be accurate to state that Exhibit F-372 is simply a blowup of one portion of 373?

Dr. Hartmann. Yes, it is; it is the first portion.

Mr. Cornwell. May we have these three exhibits admitted into evidence, Mr. Chairman.?

The Chairman. Without objection, they will be entered into the record.

[The information follows:]

*********** COMMITTEE INSERT **********

Mr. Cornwell. Dr. Hartmann, referring to the center Exhibit F-372, would it be accurate to state that the blowup there illustrates that at some points in the film Mr. Zapruder in fact doubled back instead of going forward with his panning as you would expect.

Dr. Hartmann. Yes. There is a slight doubling back, and I would just caution that there are different types of panning errors. In other words, there is this type that I sketched here. There is the type where you actually double back, but there is the type where you are going along in a straight smooth direction and suddenly move a great distance in this direction, all right, just to the right in the same direction but by more than you should have so that that produces a line, a straight line, still, and yet there is a very large error here. So don't be fooled into thinking that the only reactions or jiggles are the places where the line gets tangled. There may be some reactions in places where the line is spaced out by more than the usual amount.

Mr. Cornwell. As the exhibits were being put up, you stated that you could quantify the results of the technique applied by Mr. Scott, the same as the technique that you had applied.

I would like at this time to show you Exhibit F-176, and ask you if you can identify that.

Dr. Hartmann. Yes, sir. This is the same type of plot that was done with the set of measurements I made. The set of frame numbers are along the bottom and the amount of jiggle or blur plotted for each frame.

Mr. Cornwell. In this case it relates to the Scott technique?

Dr. Hartmann. Correct.

Mr. Cornwell. We would ask at this time that this exhibit be place3dinto evidence, Mr. Chairman.

The Chairman. Without objection it may be entered into the record.

[The information follows:]

*********** COMMITTEE INSERT **********

Mr. Cornwell. Now, in addition to the two approaches you have described, are you aware of any other way in which jiggle might be measured?

Dr. Hartmann. Yes. The physicist, Luis Alvarez, has in 1976 published in the American Journal of Physics an analysis of the same film using the third method, and that method was basically to take the set of blurs similar to what I described first, what I was quoting in my method, and his reasoning is as follows: That if the blur, if the amount of blur stays the same from one frame to the next to the next, then essentially nothing is happening. But if there is a sudden change in the amount of blur, then that is a sensitive measurement of a disturbance. And so what he plotted was the difference in blur from one frame to the next. So that is a third set of measurements.

Mr. Cornwell. When did you first become aware of Dr. Alvarez----

Dr. Hartmann. That was circulated to us on the photo panel some months ago, but I purposely did not study his results until I finished mine and Scott's.

Mr. Cornwell. I would like at this time to show you Exhibit 177 and ask you if you can identify that.

Dr. Hartmann. Yes, sir. This is an analysis or a plot showing all three sets of information on the same time scale now. So, for the first time we have a chance to really compare what the three independent and different types of measurements show, the same boxes here with the same set of frame numbers and the same timings, and, incidentally, I have noted some events as they happen along the sequence in the film, just to give you a reference to what is happening in the motorcade.

Now above the line are peaks, the greatest blurs that were measured by my technique, this is taken directly off that earlier graph. Below the line is just a flipped over image of the blurs or jiggles measured by Mr. Scott's technique, and I think you find some pretty good agreement there. And then down at the bottom in red has been added directly, hand-copied from Alvarez's graph published in his paper, the set of measurements that he made, and, incidentally, they jiggle in both directions because he kept track of what he called a postive blur in one direction or a negative in the other direction, so his are a kind of a jiggle, and ours are just motions up or down.

Mr. Cornwell. I would like at this time, Mr. Chairman, to ask that Exhibit 177 be admitted into evidence.

The Chairman. Without objection, it may be entered into evidence at this point.

[The information follows:]

********** COMMITTEE INSERT **********

Mr. Cornwell. Dr. Hartmann, can you tell us, from the analysis that you have just described, precisely when the shots were fired?

Dr. Hartmann. Well, in my opinion, if you look only at this record of blur, in spite of the fact that there is pretty good agreement, it would be very difficult to say that a particular episode of jiggling here, a particular set of blurs, is the response to a gunshot.

The question is, we believe, that if there was a loud gunshot, there probably was a startle reaction. But there could have been other kinds of reactions that would cause jiggles, just false alarms. And so on the basis of looking just at the blur, I would say no.

However, if we then look at the photo visual evidence of what is happening in the parade, I think we can begin to identify some of these as gunshots.

Mr. Cornwell. Would you explain that if you could in relation to Frame 313----

Dr. Hartmann. Yes.

Mr. Cornwell. ----where the gunshot occurred?

Dr. Hartmann. That, in particular, is perhaps the most significant one, where we know that there has been a gunshot. And we see that there is a very strong episode of this jiggling initiated at that time. The lapse time the jiggles begin--of course one has to define how do you detect when the jiggle really begins?

And perhaps the best way is to go, is to look at the frame group from when the jiggle initiates to when it reaches a maximum. In this case that is about 313 to 319. The shot was probably fired at 310, as I mentioned before, and that number of frames is consistent with the measures of startle reaction time that were reported in the book that I mentioned. So I think that is a good confirmation that we are really seeing here the reaction to both the sound of the gunshot and probably the visual sight of what happened on that shot.

Mr. Cornwell. And would it be accurate to state that the second largest area of blur or jiggle, apart from the one which occurred shortly after the head shot, would be in the earlier portion of the film?

Dr. Hartmann. That is correct.

Mr. Cornwell. What frame is that associated with?

Dr. Hartmann. About Frames 190 to 200 there is a strong blur reaction initiated. So having concluded that this is in fact, that the blur sequence around 313 to 319 is in fact a response to the gunshots, I would think that the logical inference would be that the blur sequence, the blur episode, running typically from 190 to 200 is also a response to a possible gunshot. And we know that the President emerged from behind the sign somewhat later, some frame later, showing in fact a reaction to such a wound. So this could very well be the blur or startle reaction to the gunshot that caused the back wound to the President.

Mr. Cornwell. And what, if any, corroboration is provided by this analysis to the Warren Commission's conclusion that the President and the governor may have been shot in the vicinity of Frame 210.

Dr. Hartmann. Yes, they picked 210. I would say that to pick 210 in the face of this current evidence, to pick 210 as the time for that first shot, which is the Warren Commission's conclusion, would not be warranted from this evidence, because the blur before Frame 210, from 190 to 200, is clearly much larger than any blur after Frame 210. In fact, there is really very little evidence for a blur in the appropriate amount of time after Frame 210.

Furthermore, there is some photo evidence that tends to support the thought of a shot in the time frame shortly before 190. For example, there is the Phillip Willis photograph which shows Mr. Zapruder in the background and the motorcade passing in between. Because the motorcade is in between, it is quite possible, quite easy, to determine exactly which Zapruder frame that corresponds to, because you can tell which part of the motorcade is passing between Zapruder and Willis. And Willis said that he took that photograph as a reaction. He pressed the shutter as a reaction to what he perceived as the first shot, at least a shot.

Well, it turns out that that frame is 202. So that means that Mr. Willis is telling us that he pressed the shutter as part of his reaction to a shot, and he was reacting at Frame 202, while here we see that Mr. Zapruder is in the middle of his reaction Frame 202. So that is very nice consistent evidence that something happened, say, in 190 or shortly before 190.

Mr. Cornwell. Mr. Chairman, I was incorrect earlier when I stated that Exhibits F- 224, 225, 226 and 227, the Zapruder film blowups, had been previously admitted into evidence. I would at this time ask that they be admitted into evidence.

The Chairman. Without objection, they may be entered into the record at this point.

[The information follows:]

********** COMMITTEE INSERT **********

Mr. Cornwell. I have no further questions.

Thank you, Dr. Hartmann.

Dr. Hartmann. Thank you.

The Chairman. The committee will defer questioning of this witness until later this afternoon after the committee has had the advantage of hearing the acoustical evidence, which will come into the record shortly.

Sir, we will defer our questioning of you until later this afternoon.

Dr. Hartmann. Thank you.

The Chairman. Thank you.

The Chair recognizes Professor Blakey.

## STATEMENT OF G. ROBERT BLAKEY, CHIEF COUNSEL

Mr. Blakey Thank you, Mr. Chairman.

In September 1977 the committee learned of the existence of a Dallas police tape, one that had recorded the sounds of the assassination from the transmitter of a motorcycle policeman who had accidentally left his microphone switch in the 'on' position.

There was immediate hope that by scientifically enhancing the tape, the sound of the shots could be made audible.

The committee was told by the Dallas Police Department that all of its assassination evidence had been turned over to the FBI. It did not have a copy of the tape. One was obtained, nevertheless, from Mary Ferrell, a critic who lived in the City of Dallas.

The committee then set out to find an acoustical consultant to analyze the tape. After consideration of five candidates, the committee picked the firm of Bolt, Beranek and Newman of Cambridge, Massachusetts.

Bolt, Beranek and Newman can count among its many important forensic accomplishments an analysis of the tape-recorded sounds of the Kent State shooting incident in 1970 and discovery of the 18-minute gap in the Watergate tapes.

BB&N first analyzed the segment of the radio program, 'Four Days that Shook the World,' that had been believed to have covered the assassination. As it turned out, it was not contemporaneous with the actual shooting of the President.

The committee then forwarded the tape it had obtained from Mary Ferrell to BB&N, but no audible sounds could be discerned in the analysis.

Meanwhile, committee investigators working on the case in Dallas were in contact with Paul McCaghren, a retired assistant polite chief who had been assigned to a special Dallas police assassination investigting squad.

McCaghren was one of several Dallas police veterans who donated their firsthand knowledge of the city to the committee. They 'read us into their backyard,' so to speak, as one of our investigators so aptly put it. Their help has been invaluable.

Among the original documents and tapes that McCaghren supplied the committee was a crucial November 22, 1963 dispatch tape along with the dictabelts that recorded the transmission from the motorcycle with the open mike. These materials were promptly sent to Bolt, Beranek and Newman.

To supplement the analysis of the tape, BB&N experts also went to Dallas last month to conduct an acoustical re-enactment based on the live firing of a rifle in Dealey Plaza.

In these tests, the DPD was exceptionally cooperative. It obtained weapons, constructed the bullet 'traps' and re-routed traffic during the five hours of testing. Police marksman fired rounds from the Book Depository, as well as from the 'grassy knoll.'

The final results of this work have only recently been received by the committee. Nevertheless, they have been thoroughly analyzed.

The man in charge of the Bolt, Beranek and Newman acoustical analysis is Dr. James E. Barger, the firm's chief scientist.

Dr. Barger received a B.S. in mechanical engineering from the University of Michigan in 1957, an M.S. in mechanical engineering from the University of Connecticut in 1960, and an A.M. in applied physics from Harvard University in 1962.

In 1964 he received a Ph.D. in applied physics from Harvard University. He has been a sonar project officer at the U.S. Navy Underwater Sound Laboratory, a research assistant at Harvard University's Acoustics Research Laboratory, senior scientist and director of the Physical Science Division with Bolt, Beranek and Newman, Inc.

Dr. Barger is the author of numerous scientific papers. He has lectured in the field of applied acoustics in the United States and Canada and currently is a lecturer on sound scattering and reverberations with Bolt, Beranek and Newman's anti-submarine warfare course.

He has been a National Science Foundation Fellow and currently is a fellow of the Acoustical Society of America. He is also a member of the U.S. National Advisory Board for Underwater Sound Reference Services.

As chief scientist with Bolt, Beranek and Newman, Dr. Barger personally supervised the analysis of the 18-minute gap on the Nixon-Watergate tapes and the analysis, as I noted previously, of gunfire sounds recorded during the shooting episode at Kent State University.

Mr. Chairman, it would be appropriate at this time to call Dr. Barger.

The Chairman. The committee calls Dr. Barger.

Doctor, would you stand and be sworn?

Do you solemnly swear the testimony you will give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Dr. Barger. I do.

The Chairman. Thank you. You may be seated.

Mr. Cornwell.

Thank you, Mr. Chairman.

Dr. Barger, I would like to first direct your attention to the point in time that our chief counsel just made reference to, namely, when the committee brought to you a tape recording and a Dictabelt from the Dallas Police Department's recordings of transmissions on November 22.

At that point in time, what did the committee ask you to try to do with that tape recording?

## TESTIMONY OF JAMES E. BARGER

Dr. Barger. Mr. Cornwell, there was a series of questions that were asked in increasing order of difficulty.

The first question and the least difficult potentially to answer was, simply, was the motorcycle with the stuck transmitter likely to have been in Dealey Plaza, and if so, were they the sound of shots recorded thereon or detectable thereon, and if that turned out to be the case, how many shots, and if that could be determined, what was the sequence between them, and if that could be determined, from what locations were the shots fired, and if by chance that also could be determined, what weapons fired the shot?

Mr. Cornwell. Would there be some reason to believe that you could answer any or all of these questions?

Dr. Barger. Well, the reason to believe that there may be answers to the latter questions was, of course, less likely than the former ones, but the answer is generally yes. The tapes had a good deal of noise on them, motorcycle noise, crowd noise, radio frequency inference, and the like. The most serious problem was the motorcycle noise. There is a way to help reduce that. It is a technique called adaptive filtering. It considers that the motorcycle is a repetitive device. As the cylinders fire, they do so periodically. The adaptive filter can learn to understand the event and project what will happen the next time the piston fires and subtract that noise out from the tape.

We then thought once the adaptive filtering was conducted, the tape might then be noise-free enough to attempt a detection of the sounds of gunfire.

Now it was perfectly clear that these sounds were not clearly audible. There is a field of detection theory--well, the field of detection theory has a favorite approach called matched filtering. The matched filter is a device that is used to detect events that you have some understanding of, even though they are subaudible. Matched filters are used in radar sets commonly to detect the presence of impulsive signals in noise, even though they are not visible or audible in the raw data themselves. There was reason to believe that applying these techniques we might be able to detect the impulsive sounds of gunfire.

Mr. Cornwell. What, if anything, gave you reason to believe that you might be able to determine the direction from which gunfire came or the fact that it was gunfire?

Dr. Barger. When an impulsive source of sound is generated in an enclosed or semi-enclosed environment, such as an urban environment, the impulsive sound spreads from the place where the sound was generated in all directions and is reflected, scattered, defracted into all possible receivers, such as microphones that might be stuck and such as ears.

Now the signals, the impulsive signals, that arrive at these receivers--microphones or ears--over all of these paths that have arrived through the processes of reflection, defraction and scattering, occur in a unique pattern, and that pattern depends on where the source of sound was and where the receiver is at that time. This unique pattern can be learned by, for example, reconstructing the sound of the acoustical event and measuring the pattern, and it can be expected to be quite unique.

If the microphone or receiver moves from one place to another, the pattern will change, and it is in fact these echo patterns that are the matching patterns that we considered using in the matched filter as a very powerful method for detecting the possible presence of gunfire in the tapes.

Mr. Cornwell. Let's begin with what you describe as the unique sound of gunfire, and at this point show you Exhibit F-357.

First, will you simply tell us what that is?

Dr. Barger. This is an exhibit that illustrates the acoustical disturbance generated by a rifle firing a subsonic bullet in free space.

Mr. Cornwell. At this time, Mr. Chairman, I would ask that that exhibit be admitted into evidence so that we may ask Dr. Barger further questions concerning it.

The Chairman. I am sorry, Counsel?

Mr. Cornwell. I would like to ask at this point if that ehxibit might be admitted into evidence.

The Chairman. Without objection, it may be entered.

[The information follows:]

********** INSERT 1C1 ********

Mr. Cornwell. Would you at this point then, Dr. Barger describe this phenomenon used in the exhibit?

Dr. Barger. This simple diagram shows the location of a rifle firing a supersonic bullet along this horizontal trajectory. At the instant in time that this illustration depicts, the bullet is at Position 1. The sound generated by the muzzle blast is expanding spherically around the origin of the gunfire, namely, the muzzle of the rifle.

At the time depicted here, that impulsive sound spherical surface has reached the point shown by the circle. The bullet, however, being faster than the speed of sound has advanced beyond the position of the sound wave, and it generates a shock wave as a supersonic transport would going supersonically, and the locus of that shock wave is from the bullet itself to the tangent of the sound wave at this point. At a later time the bullet will have advanced, and the shock wave would have--and the sound wave would have expanded to the position shown here. At this time the bullet has advanced to this point. The sound wave has expanded to this point, and the shock wave has progressed to this region.

If an observer were at this point, at the first time that I showed, when the bullet was at this point, the observer would hear the shock wave because it would pass him at that time.

At the second time that I show here, when the bullet is advanced to the second position, the sound waves of the rifle would reach the observer at that point and he would then hear the muzzle blast.

You have emphasized at several points that this is a diagram showing the principle with respect to a supersonic bullet.

What, if any, differences would you find if the bullet were subsonic?

Dr. Barger. If the bullet were subsonic, in the first time that I have shown when the muzzle blast has reached this point, the bullet would have lagged behind the position of the sound wave at that point, and it would always be behind getting farther and farther behind as time went on, and no shock wave is generated by that bullet.

Mr. Cornwell. If you wanted to look at those principles on a recording, would there be a way that you could do that?

Dr. Barger. Yes. This observer is the same as the receiver I spoke of earlier. It could be a microphone or an ear, and therefore what I said for this observer holds for the person in question.

Mr. Cornwell. I would like at this point then to show you Exhibit F-364 and ask you if you could tell us what that is.

Dr. Barger. This is an illustration of the shape of the acoustical waveform generated by two rifles.

Mr. Cornwell. At this point, Mr. Chairman, I would like to ask that Exhibit F-364 be admitted into evidence.

The Chairman. Without objection, it may be entered into the record at this point.

[The information follows:]

********** INSERT 1C2 **********

Mr. Cornwell. Would you now, Dr. Barger, tell us what that ehixibt illustrates?

Dr. Barger. At the top of the illustration we show the acoustical waveform of both the shock wave and the muzzle blast from a Mannlicher Carcano. The shock wave as measured by a microphone 10 feet from the trajectory of the bullet and the muzzle blast was measured by the same micropone which was at the same time 30 feet from the muzzle.

The shock wave, all of the acoustical pressures are plotted here as a function of time measured in milliseconds. The shock wave is a very sharp event looking something like the letter ''N,'' and in this case, with this weapon, the peak pressure of the shock wave is 130 decibels.

Now let me just briefly describe the decibel as a measure of acoustical intensity. It is, in case anyone wants to be certain, the reference pressure for the decibels that I describe are 2 times 10 to the minus 15 newtons per square meter, the currently standard pressure, and with respect to that pressure, the shock wave as an intensity of 130 decibels.

The muzzle blast at 30 feet is more intense. It has an intensity of 137 decibels.

Let me just give you a few facts about decibels that will help make this clear.

If two sounds are otherwise similar but have a different loudness, a different intensity by 10 decibels, the louder of the two will sound twice as loud. On the other end of the scale, if two sounds are so slightly different in intensity that you can just perceive that difference, they will be different by 3 decibels.

The muzzle blast then, more intense by 7 decibels, sounding almost twice as loud, not quite, having a very sharp peak, a negative undershoot followed by quiescence, those are characteristic of the waveforms of that rifle.

A rifle firing a bigger charge is the M-1 rifle. It also has a faster round. The muzzle velocity of the Mannlicher Carcano is about 2,000 feet per second. The M-1 is close to 3,000. Therefore the intensity of the shock wave radiated by the M-1, being about 140 decibels when measured 10 feet from the flight path, the muzzle blast is also more intense. At 30 feet it would be about 145 decibels, being something less than twice as loud as the Mannlicher Carcano.

Mr. Cornwell. I suppose we are all aware that the Dallas Policy Department found a Mannlicher Carcano on the sixth floor repository and the Warren Commission concluded that was the weapon used in the assassination. So I guess from that we could assume why you chose a Mannlicher Carcano in the top graph to illustrated principles you just described. But why did you choose an M-1 to illustrate in the lower portion of the graph?

Dr. Barger. Well, for one reason we had the data. The principal reason waa that it is the loudest rifle that one could conceive might have been used in that environment. And the purpose then is to show that the loudest one one might conceivably use is less than twice as loud.

Mr. Cornwell. I would like to now direct your attention to the part of your previous resume that referred to the fact that you might be able to locate the shots and ask you if you would direct your attention at this time to Exhibit F-334.

Dr. Barger. Yes. This is what is known in the field of scientific presentation as a cartoon. It illustrates the formation of echo patterns in urban environments.

Mr. Cornwell. At this time, Mr. Chairman, I would ask that Exhibit 334 be admitted into evidence.

The Chairman. Without object, it may be entered in the record at this point.

[The information follows:]

********** INSERT 1C3 **********

Mr. Cornwell. Would you explain then what the principles are that are illustrated by that?

Dr. Barger. Yes. I have said we are aiming for the application of a matched filter to the Dallas Police tape that Mr. Blakey described, seeking the possible detection of gunfire thereupon.

Now the pattern that will be the match in this filter would be an echo pattern as generated at a receiver, such as a microphone, and an urban environment that has buildings from an impulsive sound that might have been generated in one of them.

In the lower figure here, we show, along the horizontal scale, time increasing, and in the vertical scale here the amplitude of sound that might arise at any particular time.

Npw the sound from the muzzle of the rifle expands strictly, as I showed in the first exhibit, and along this direct path, which is the path having the least link between the source and the microphone, traveling the direct sound, and that having the shortest path is the first one to arrive. But I have illustrated that there are two here very close together.

The reason for that is that very next to the direct path is another ray of sound that hits the street just below the microphone and bounces and reflects up into the microphone, those two paths have very nearly the same length, therefore, they occur at very nearly the same time, and they have very nearly the same amplitude, so I have plotted them at this same point.

Now sound propagating in this direct path loses energy only by spreading out to fill the sphere that I described in the first exhibit. Sound paths having the next highest amplitude are those that are reflected from the surface of a building. Reflection occurs whenever the angle of the sound ray incident upon the building is reflected from it at the same angle. The same sound that hit the building was reflected off. It is still going after reflection in only one direction, just as it was before reflection. Therefore, it has not been diminished in intensity. It has merely had the direction of its propagation changed, and it then comes and hits the microphone as does another similar path hit the street and then the microphone. These two paths being longer occur later. They are marked with R-1 and 2 here, illustrating the reflected direct and reflected surface bounce path.

RPTR COCHRAN

The sounds that comprise echo patterns that have the next stronger amplitudes are the defractive paths. These paths hit large edges such as the corner of a building. Now when the sound strikes the corner of that building, it is spread out in a plane that I am now describing with this pointer. It goes into all directions within that plane, including the direction of the microphone. Since some of the sound that hit that corner at that time went in other directions it is diminished in amplitude at the time it arrives at the microphone and therefore Path M that I just described, which is clearly shorter than the Path R because this corner is closer to this source than was the reflection path right there, with the lower amplitudes than the reflective path had.

The furtherest corner of the building did give a defractive path similarly.

Now, we have discussed refractions and defractions.

The third most important, but generally the weakest method of changing the direction of sound is by scattering. I have illustrated a parallel pipedon here which represents people or automobiles or anything of small size. When the sound hits an object of small size, it is sent out in all directions, including the direction of the microphone.

Having been sent in all directions in space, it is diminished in amplitude considerably, so only if that scattering is close to the microphone, as I have shown here, or if the scattering object, namely this windowsill, is close to the source, as I have shown here, will those paths have sensible amplitude.

In order to have significant amplitude, they have to--the scattering object has to lie close to the direct path.

Therefore the travel time over the scatter path has to be only slightly larger than the trail time over the direct path and therefore, right after the big one, you see lots of little ones that are scattering from small objects.

There are other buildings, of course, in a typical urban environment and so there are deflective and refractive sound paths coming in, as I have indicated by the ''u'' here from other directions. They will occur at later times because they come from buildings further away and they will be scattered out in time here.

A cursory examination shows we would expect echo patterns that would persist for about one second. In that period of time there would be on the order of ten or twelve reflected and defracted and scattered paths having significant amplitude, namely, amp above some threshold below which you are passed by noise.

Mr. Cornwell. If I understand correctly then, the sound would travel at the same rate of speed after it hit any of those surfaces no matter whether it was reflected or scattered or whatever and therefore the spacing of the marks on a time scale would be determined strictly by the distances that the sound had to travel from its source to the microphone, is that correct?

Dr. Barger. That is correct.

Mr. Cornwell. In your hypothetical urban environment that you show there on Exhibit 334, how many differnet points of sound source, or different locations for a point of sound source, at how many different locations for a microphone might you expect to produce the exact same spacing of the points on the time scale and amplitude at those points?

Dr. Barger. It is clear that moving the position of this microphone in any direction will alter the relative length of the sound paths and therefore alter the spacing between them. If there are enough different reflectives and scatterers, then the pattern achieved at any particular point is unique and would not be replicated in any other point.

Mr. Cornwell. If we had a time scale such as shown at the bottom, you would expect that to be produced about from a sound only in one place in the environment and at a point where the microphone or receiving ear was located at only one point?

Dr. Barger. That is correct. In the absence of noise, if you could measure this patterny precisely it would uniquely fix the position of the microphone.

Mr. Cornwell. Now, you told us earlier that at the point at which you received the tape recording here in question--I take it you listened to it and it had a large amount of noise or static in it, is that correct?

Dr. Barger. That is correct.

Mr. Cornwell. What did you do after initially listening to this recording?

Dr. Barger. Initially we listened to the whole tape and we found at one point on the tape there was a five and a half minute segment in which the sound of a motorcycle engine and other noises were heard continuously. This particular five and a half minute segment was the period of the stuck microphone button that Professor Blakey described earlier.

The sound in that five and a half minutes was mostly motorcycle noise. However, there was a period half-way through it approximately where the motorcycle noise diminished. That is a brief description of what we heard.

Now, as I said, we realized from the outset that we were seeking to detect sub-audible events or at least not audibly recognizable events and this is helped by looking at the electrical wave form that represents the sounds in a form called a wave form draft. So the first thing we did was to digitize the sounds in this five and a half minute tape recording to form a computer file of the information contained by that digitalization and then plot out a draft showing the wave form on the tape. This process was conducted by Dr. Wolf at BBN and generated about 234 linear feet of wave form.

Mr. Cornwell. I now show you Exhibit F-335 and ask you if you can tell us what that is?

Dr. Barger Yes. That is about ten feet of the 234 feet of wave form.

Mr. Cornwell. I would like at this time, Mr. Chairman, that that exhibit be admitted into evidence.

Mr. Stokes. Without objection, it may be entered into the record.

Mr. Cornwell. What,if anything, did you learn from the production of this type of draft and your analysis of it?

Dr. Barger. This exhibit shows the wave form of the sounds on the tape displayed at fifty inches per second starting 130 seconds after the onset of the stuck microphone button and extending to the time of 141.6 seconds t thereafter.

Of course, it is difficult to see here without a telephoto lens but I will describe it to you. This continuation of rather constant level noise is typical of what preceded this segment for about two minutes. It is motorcycle noise. At this time, about 132 seconds after the microphone button became stuck, it is clear that the amplitude of that noise is diminishing. Shortly after that time, a series of impulsive events are seen in the tape. We concluded that it is possible that some of these impulsive events are in fact what an echo pattern would look like as transmitted through the radio in question.

Mr. Cornwell. In addition to the motorocycle noise, did you find on your graph other types of noise or static, something like that?

Dr. Barger. Yes. I just mentioned briefly that in addition to this continuum of noise which sounds like and apparently is motorcycle noise, there are sharp impulsive events of this type. They occur from time to time. Many of these have become understood by us to be impulsive events caused by other radios when they key in and attempt to transmit on this radio channel as well.

Mr. Cornwell. After fifteen years in what condition was the tape? Did that possibly have any effect on the level of noise that you found?

Dr. Barger. The possibility that some of this noise was caused by the tape recording process is clearly a real one. The noises generated by the motorcycle are so intense that the sounds of--the noises generated by the recording process are relatively less. Therefore that is not the principal source of disturbance.

Mr. Cornwell. After reviewing the output in this form, what did you do next?

Dr. Barger. We realized that we could see impulsive events occurring at times after the motorcycle noise diminished of its own accord. We have then to determine whether such impulsive events might also be present in the tape recording at earlier times before the motorcycle in fact quieted down. We decided the best way to do that, as I mentioned briefly before, would be to filter this tape recording through an adaptive filter that would, as I described it, learn about the motorcycle noise, project slightly ahead, and subtract it out.

Mr. Cornwell. There might be members of the committee who are familiar with some types of filters, but is the particular type that you needed for this process, was it available in 1963?

Dr. Barger. No.

Mr. Cornwell. When, approximately, would it have been developed, if you know?

Dr. Barger. I am not exactly sure. The type of adaptive filter we used is called a Widro adaptive filter. We used the least means squares logarithm to figure the filter weight. I don't believe that process was described in the literature until 1968 or so.

Mr. Cornwell. I would like to show you Exhibits F-336-A and F-336-B. Would you tell us what those are, please?

Dr. Barger. These are about 18 feet of the wave forms that were obtained by filtering the motorcycle tape through the adaptive filter. The beginning time of this segment is 130 seconds after the onset of the stuck button as was the previous exhibit, in this case, the terminating time being 150 seconds.

Mr. Cornwell. I would ask at this point, Mr. Chairman, that Exhibits F-336-A and B be admitted into evidence.

The Chairman. Without objection, they may be entered into the record at this point.

[The information follows:]

*********** INSERT ***********

Mr. Cornwell. Did you learn anything new from reviewing the data in this filtered form?

Dr. Barger. Yes, we did, but these are sufficiently indistinct to you that you wouldn't be able to tell it from where you are sitting.

The amplitude of the noise in the portions of the record where the motorcycle was heard most loudly have been reduced relative to the amplitude of the signals in the period where the motorcycle noise had previously and is still quiet.

It, therefore, enabled us to examine those portions of the tape that were recorded when the motorcycle was running faster and during which time the noise of the motorcycle was perhaps obscuring any impulsive sounds that might in fact appear to be echo patterns.

Mr. Cornwell. What, if any, technique did you apply to learn more about the data after receiving it in this filtered form?

Dr. Barger. After examining the 234 feet of filtered tape, we discovered there were no other impulsive events on the tape that had been massed by the motorcycle noise with one exception. That impulsive series of events came near the end of the five-minute segment and was very unlike the series of impulsive events that we see before us here, at times around 130 seconds after the stuck button.

Mr. Cornwell. What, specifically, did you do to determine what the nature of the impulsive events were?

Dr. Barger. At this stage we conducted a series of tests which we call screening tests, to determine whether those impulsive events might be ruled out as gunfire. I might add before we did that we did attempt some different analyses beyond those that I have described so far that would help us understand the nature of the impulsive events that we did in fact perceive.

The first of those analyses, in fact, was a calculation of the spectrographic analysis of the transient event.

Mr. Cornwell. I would like to show you Exhibit 356 and ask you, would it be possible for you to use that exhibit to illustrate the analysis, the spectrographic analysis you just mentioned?

Dr. Barger. Yes. This exhibits makes up two spectrographs of two segments of the tape recording that help explain the presence of some of the impulses on the tape.

Mr. Cornwell. May we have Exhibit F-356 admitted into evidence, Mr. Chairman?

The Chairman. Without objection it may be entered at this point.

[The information follows:]

********** INSERT 2-a *********

Dr. Barger. There were a series of impulsive events on the tape that were particularly numerous at times around 145 seconds to 150 seconds. These are shown in a spectrogram as follows:

The time on the tape is marked on the horizontal scale in seconds.

The frequency of the energy in the sounds on the tape at that time is marked on the vertical scale in kilohertz. At this point half a kilohertz is the frequency approximately equal to the pitch of Middle C on a piano. The intensity of these spikes--the distance the spike reaches upward in this plane indicates how sharp it is, how much high frequency content it contained, but that is about all.

The interesting thing shown are these horizontal dark bands. The horizontal dark bands are the sounds made visible in the spectrogram that are caused by the heterodyning between two radio transmitters. The radio transmitter with the stuck microphone is transmitting for sure. There are other radios that seek to transmit on the channel, press a button which puts their carrier frequency into the air as well.

The carrier frequencies of the two radios are not exactly the same. They beat between each other and generate what is called a heterodyne tone, a beep. The picture of that beep which would be determined by where it was positioned in the vertical dimension of the spectrogram is dependent on the exact radio in question and what his carrier frequency really is.

We can see there are heterodyne tones with this pitch, this pitch and this pitch, and even with this pitch. That indicates that during this time there were at least four other radios that were briefly trying to transmit by pressing their talk button.

When they realized the channel was still in use, they let it up. So the time between when they push the button which generates a transient until the time they let up the button, which generatges a transient, there is a heterodyne tone observable in the spectrogram. These tones were sub-audible on the tape so the spectrogram revealed their presence. Whenever there were a pair of impulses with a heterodyne tone, we knew those were generated by another transmitter and were not associated and should be eliminated from consideration as possible members of an echo pattern.

Mr. Cornwell. In addition to the spectrographic analysis you have just described were there any other techniques that you utilized in order to determine whether or not the impulses on the tape were in fact associated or might be associated with gunfire.

Dr. Barger. Yes, there was one in particular. We wanted to demonstrate there were audible acoustical sounds on the tape. The sound of a bell tone at 152 seconds from the time of the stuck button was vaguely evident. We wished to analyze that segment of the tape with an energy spectrum.

Mr. Cornwell. I show you Exhibit 355 and ask you to tell us what that is.

Dr. Barger. This is what I just described. Thge energy spectrum of the segment of the tape that contains the toll of the bell.

Mr. Cornwell. May we have Exhibit F-355 admitted into evidence, Mr. Chairman?

The Chairman. Without objection, it may be entered into the record at this point.

[The information follows:]

*********** INSERT 2-b ***********

Dr. Barger. In this exhibit the frequency of each component of sound is plotted on the horizontal scale and the loudness of that component is plotted on the vertical scale, again in decibels.

The nature of an energy spectrum, if you have nothing in the record except noise, is a rather jiggly tone sometimes described as a hairy line that is rather gently undulating in the frequency domain.

However, if there are periodic components in the sound, such as generated by a bell or an overtone of a bell, they will generate a spike in the spectrum such as these spikes that are clearly visible in this exhibit. In fact, there is a harmonic series of periodic events that are visible in this record and we have labeled them with the number one to represent the fundamental two, three, four, five, six, to represent the harmonic overtone.

This particular spectrum which was calculated by Mr. Schmidt has been done over a third of a second of the tape that was identified by the audible, but barely audible sound of this bell.

Now, there is a very interesting feature in this spectrum and that is in particular this particular peak. The reason this is of significance is as follows: It is characteristic of the design and manufacture of carillon bells that they contain a harmonic series such as I have numbered here.

The fundamental frequency is in a description of carillon sounds called the hum note. The second harmonic is called the strike note and that is the note to which the bell is tuned.

In this case that is 440 hertz, which is A bell or Middle C.

They characteristically have a minor third above them and this is at the right frequency ratio to the strike tone to be the minor third of a carillon bell. They typically have a fifth and upper third above them and both of those overtones are clearly evident in the spectrum of this bell. It is not at all unlikely that a strong seventh overtone of the hum note would appear. This, therefore, is a very clear indication that that bill is a large carillon bell. The sound of it would reach this tape recording only through the acoustical path.

Mr. Cornwell. So somewhat similar to the spectrographic analysis technique, applying the energy spectrum analysis you were again able to identify transients or short peaks in the data which were not associated with gunfire?

Dr. Barger. That is correct.

Mr. Cornwell. At this point when you had filtered the tape and you had eliminated both background noise, such as the motorcycle and a number of other transients using techniques you just described, what conclusions were you able to draw at this point from your analysis?

Dr. Barger. We concluded there were sounds of acoustical origin on the tape, giving us confidence that the acoustical part of the otherwise partially malfunctioning transmitter was working.

We found that there are impulses on the tape that are unique to the segment following 130 seconds from the onset of the stuck button and a cursory examination of those impulses indicated that we could not rule out the possibility that they were in fact echo patterns.

Mr. Cornwell. What did you do next?

Dr. Barger. Well, it seemed prudent to do something more than a cursory examination of the echo patterns so we devised six what we have called screening tests to determine if they might in fact be the sounds of gunfire and if we passed these six screening tests we would proceed to the filter detector which I described before which was in the back of our minds as the most powerful test we could perform.

The point was, did the impulsive patterns on the tape occur at the time of the assassination? The second screening test was simply, were these patterns that occurred at this time in the data unique throughout the 5.5 minute segment? In other words, could they be shown to have occurred only once?

Thirdly, we asked, did the span of time occupied by the impulse patterns cover at least five seconds? Or, of course, if they did not, they could not possibly represent the entire span of the gunfire as given by analysis of the Zapruder film.

Fourthly, we asked, do the shape of the impulses on this tape recording resemble the shape of impulses of gunfire transmitted through that type of radio? They certainly didn't resemble the wave forms of gunfire as I showed in the first exhibit, but the radio would be expected to distort them and would it have distorted them in the way they appeared on the tape?

Does the narrow range of observed amplitudes of the impulses on the tape correspond to the expected range of amplitudes for the wide range of echo amplitudes as compressed upon transmission through the radio?

The sixth one. Do the number of impulses that we would expect in an echo pattern approximate the number of impulses that are seen in the tape to occur at this time? Those six questions were asked and they received an affirmative answer.

Mr. Cornwell. Let me ask you--I believe your explanation perhaps was clear that you wanted to find out if they occurred at the right time of day; if they were unique. In other words, if they were not so thoroughly scattered throughout the data they were the cause of something else. That their shape was appropriate; that they had the right amplitude or height after the compression of the radio; that there was approximately the right number of impulses, but you also stated--I believe your third item was that the time span had to be at least five seconds.

Do I understand--you made reference to the Zapruder film--that a matter of looking at the head shot at 313, or 312 and going back into the film at which point I suppose everyone would agree that the participants, the President and Governor Connally, are clearly reacting and saying that there was at least in a minimum period of time, five seconds, that the shots had to cover. Is that accurate?

Dr. Barger. That is accurate.

Mr. Cornwell. So no matter what else might ultimately be found out about the number of shots or the timing or sequencing or anything else, you at that point were looking to see if it at least covered a five-second span?

Dr. Barger. That is correct.

Mr. Cornwell. Let's go to the first test and show you Exhibit F-366 and ask you if you can tell us what that is?

Dr. Barger. Yes. This is an illustration of how we attempted to achieve our best estimate of the time of the assassination.

Mr. Cornwell. May we have Exhibit F-366 admitted into evidence, Mr. Chairman?

The Chairman. Without objection, it may be entered at this point.

[The information follows:]

********** INSERT 2-c **********

Dr. Barger. The data depicted in this exhibit were obtained by listening to Channel 2 of the Dallas Police Dispatcher System. Channel 2 was in use on that day and at that time by, among others, the Chief of Police, who was in the lead car just ahead of the President.

Channel 2, like Channel 1, was recorded; the sounds that were carried over Channel 2, like 1, were recorded. They were recorded on a Gray Audograph which unfortunately records intermittently. When a radio is braodcasting a signal, the recorder turns on and records the sounds. When no one is recording, the recorder stops. This saves recording space.

As a result of that feature, when we--in the laboratory, while listening to that tape recording, with a stop watch, timed the annotations that the dispatcher read out from reading his clock, as listed on the horizontal scale, we got a dot that we can plot on the graph for each time he gave an annotation.

For example, if he said 12:28 and our stop watch read 5.5

minutes we would put a dot there.

If he then said 12:28 a half minute later, which was not uncommon--in other words, he would only annotate the tape to the nearest whole minute--we would then note the time that that was heard and plot that point.

Now we have then obtained the stop watch time or we might say the laboratory time, plotted against the clock time that the Dallas police dispatcher on Channel 2 had on that date and the data follows this bent line.

When one has data of this sort one draws a straight line through them by a mathematical procedure called a least squares fit. This straight line that you have drawn becomes your best estimate of the time corresondence between your watch and the laboratory and between the Channel 2 dispatcher's clock and the Dallas Police Department.

At times prior to 12:30 the best estimate by the least squares procedure of the correspondence between laboratory time and Dallas police Channel 2 time is a line that has a slope less than one. This indicates that on the average the recorder used to record the dispatcher's voice was running very slowly. The reason that perception is given is that it was actually off part of the time when no one was speaking. However, at about 12:30 the voice traffic increased so much on Channel 2 that the recorder operated then continuously and therefore our estimated correspondence between laboratory time as measured on the stop watch and Dallas dispatcher 2 time with the slope of one. That means the recorder is on all the time.

Well, that is not tremendous information. However, the purpose for doing this was to note with the stop watch that at this time, as we listened to the tapes, we hear the Chief of Police say, ''We are approaching the triple underpass.'' And nineteen seconds later on the stop watch we heard him saying, ''We are going to the hospital.''

Since it has been recorded that the Chief of Police heard the shots and since he has testified that he has heard them, it is unlikely that he would give a routine position report after having heard them so it can be presumed or should be presumed that the assassination occurred sometime between those two voice transmissions by the Police Chief.

If one then goes over horizontally from that time estimate to our estimated correspondence of Channel 2 time to our stopwatch time we have our estimate for the time of assassination, which is 12 seconds past 12:30.

Mr. Cornwell. I now show you Exhibit F-365 and ask if you can identify that.

Dr. Barger. This is the same kind of activity but conducted when listening to the sounds on the Channel 1 tape.

Mr. Cornwell. May we have Exhibit F-365 admitted into evidence, Mr. Chairman.

The Chairman. Without objection, it may be entered into the record.

[The information follows:]

********** INSERT 2-d **********

Dr. Barger. The purpose here is to determine at what time the impulsive sounds on Channel 1 occurred to see if they were at the same time as the time of the assassination.

Here is the time read on the clock watch that is observed by the dispatcher on Channel 1 in the Dallas Police Department, which is a different clock than that observed by the dispatcher on Channel 2. This is Channel 1 dispatcher time; this is laboratory time measured with a stop watch.

This dispatcher was more plentiful and the time annotations that he gave--for example, he gave three time annotations at the time 12:26 and so we have more data here upon which to base a time estimate, using the least squares technique.

The straight line indicates a result of that time estimate.

There is nothing audible during this 5.5 minute period because mostly all you hear is motorcycle noise and so the Channel 1 dispatcher made no time annotations there. However, before and after he did--and that gave us the possibility of forming the estimate for how his clock read that date--we have on the tape the time of the first impulsive sequence that we think may possibly be gunfire and we come over to our time estimate and down and find that we estimate the first impulse to have occurred at 12:30 and 47 seconds.

Now, the estimate for the time of the first impulse then is about 35 seconds after the estimate of the assassination. If both dispatchers had been looking at the same clock, I would have had to conclude that we wold not pass this first screening test.

In other words, that the impulses occurred too late. On the other hand, each dispatcher was looking at a different clock. I have read in testimony in the Warren report that the two clocks are not synchronized except once a month at the first of the month. This was the 22nd.. The two clocks were subsequently found by the F.B.I. to be one minute off, so the variation in the times that we have discovered here is within the known accuracy of the two clocks so we have to conclude that the possibility that the impulses represent gunfire passed the first screening test; namely, that they apparently occurred at the time of the assassination.

Mr.Cornwell. So I take it then that the question of what impulses occur at approximately the time the shots were fired has been answered in the affirmative using a comparison of both Channel 1 and Channel .

Dr. Barger. That is right.

Mr. Cornwell. You have referred, of course, throughout your testimony to the fact that it was a motorcycle which you believe had its button stuck and that, of course, according to the last exhibit and your previous testimony was a thing that caused the five minute gap or a continual transmission from the stuck button on Channel 1. Is Channel 1, however, the channel on which you would expect to find that type of motorcycle transmission?

Dr. Barger. Channel 1 was the normal channel in use in Dallas. Channel 2 is used for special occasions such as the presence of the motorcade. In fact, the Chief of Police was speaking to the motorcycles at the head of the motorcade in this motorcade on Channel 2. Some of those motorcycles near the limousine were known to have been switched to Channel 2.

On the other hand, listening to the voice communications on Channel 2 at times before and after 12:30, I discovered the presence of the call numbers of several motorcycle policemen in the motorcade that were on Channel 1.

Mr. Cornwell. Moving next to the second screening test that you mentioned, namely, whether the impulses were unique, I would like to ask you if you would describe what you did to determine the answer to that question.

Dr. Barger. Yes. We examined the full 230 linear feet of the wave form representing the output of the Channel 1 recording when the button was stuck to see if there were any other impulsive patterns that occurred that were similar to these that we are looking at on Channel 1.

We found that there was one other sequence of impulsive events. It was dissimilar from the one we have looked at principally in that its time span was less than five seconds. It occurred about a minute later than the period of impulses in question. We found no other impulsive patterns on the tape.

Mr. Cornwell. So the answer to the second question is again in the affirmative?

Dr. Barger. Yes.

Mr. Cornwell. Going into Test No. 3, which was the question of whether there was a time span of at least five seconds, I would like to direct your attention to Exhibits F-336-A and B.

These are exhibits that have already been admitted into evidence. Could you use them to illustrate your analysis with respect to the third test?

Dr. Barger. The impulsive events that we felt hypothetically might represent echo patterns began at approximately 137 seconds after the stuck button commences and continued through this portion at about 147 seconds. This period of impulses, this period, this period, and this period, represent four typical segments of the tape. The span between them is ten seconds and that is more than five.

Mr. Cornwell. Now, with respect to Test 4, what impulses were of approximately the correct shape, how did you go about resolving that question?

Dr. Barger. In this case we were familiar with the shape of transient wave forms generated by rifle fire and those were shown in the second exhibit. However, we saw that those wave forms did not appear in the tape that we were analyzing.

We knew, however, that the loudness of the impulses from gunfire so near--well, anywhere in Dealey Plaza--would be so loud as to overload the radio, to exceed its capacity to transmit without distortion of the wave forms in question.

In order to test whether the Dallas radio distorted the gunfire impulses in the way or in the approximate way that we see in these records, Mr. Robinson found a similar Motorola Police department FM radio in use with the MDC Police in Massachusetts and he was able to test that radio by playing sounds of the Mannlicher Carcano rifle as tape recorded, electrically into its microphone connection, through an electronic circuit that mimicked the electroacoustial behavior of the microphone and then to go back to the receiver at the police station and make a recording of the distorted sounds that were in fact transmitted. The next exhibit illustrates those distorted wave forms he measured.

Mr. Cornwell. I show you Exhibit F-368. As you just noted, that is an exhibit which would help you illustrate the techniques you have just described, is that correct?

Dr. Barger. I anticipate that that will be the one.

Mr. Cornwell. May we have Exhibit F-368 admitted into evidence, Mr. Chairman?

The Chairman. Without objection, it may be entered into evidence at this point.

[The information follows:]

********** INSERT 2-e **********

Dr. Barger. This illustration shows on the left side wave forms due to muzzle blasts and on the right side wave forms generatged by end waves or shock waves from the Mannlicher rifle.

In this photograph we see the wave form of a muzzle blast that was measured with a good microphone from a Mannlicher Carcano. The amplitude of the muzzle blast is shown in time covering a total time of ten milliseconds.

In this case we have the wave form which is that sharp end shaped wave form shown as measured from the shock wave of the rifle, also on a scale covering ten milliseconds.

In this column we show the wave form transmitted by the radio to the receiver and subsequently analyzed at the receiver, as a function of the level of the loudness of the muzzle blast that was played into the radio. 139 decibels, very loud, 129, half as loud in terms of human response, 119, half again as loud, 109, half again as loud, 99, half again as loud.

We see that the relatively simple shape of the muzzle blast wave form is made more confused. It oscillates more; it lasts longer in time and its shape in fact depends on how loud it was. The radio therefore was performing non-linger distortion and compression on these wave forms at the levels indicated.

Here the end wave coming in at 139 decibel level has a nice pristine end shaped wave form and comes out as a lower frequency oscillation and that is true even at a ten decibel lower level, etc., but when you get down thirty decibels lower than this one actually the radio now is capable of transmitting that wave form in an undistorted form.

Mr. Cornwell. So we can see the basic distortion at different decibel levels.

Do I understand that the various decibel levels are shown because they would corresond perhaps at different distances that the blast might be from a receiver such as a microphone?

Dr. Barger. We have observed that the loudness of the muzzle blast wave forms during the test reconstruction in

Dallas measured at the microphones closest to the rifle were 135 decibels, virtually the same as the loudest here, and the loudest sounds measured at the most distant receivers were about twenty decibels lower than that, so the range of the loudest sounds is easily covered in this investigation.

It shows that one cannot hope to identify, for example, the type of rifle fire by looking at the wave form that you see because the wave form that is characteristic of the rifle is severely distorted by the radio because it is too loud for the radio.

Mr. Cornwell. I now would show you Exhibit F-369 and ask you if you can tell us what that is?

Dr. Barger. This is a graph that quantifies at least better for people who think in terms of graphs the capacity of this radio not to accept and transmit loud sounds as efficiently as it transmits weak ones.

Down here in decibels in this scale, increasing to the right are the loudness of sounds introduced into the microphone and in this scale reading upwards are increasing loudnesses of sound that are transmitted by the radio. These lines up in the loud sounds where I said the levels of sounds were where we did the test filing, 109 to 139, these lines are quite flat.

In other words, the loudness of the signals heard were thirty decibels in range from the loudest to the softest. Therefore, the loudness of the sound transmitted by the radio would only differ by ten decibels. This is described as amplitude limitation. It would indicate that all of the loud and even the softer echos in the echo patterns at Dealey Plaza would have about the same loudness on the tape that was made after transmission through the radio. It was necessary to see if the radio affected this because this removes the subjective impression of gunfire from listening to these compressed sounds.

Mr. Cornwell. Perhaps you could be seated at this point. I will ask you finally with respect to final screening test No. 6, concerning the question of whether or not the number of impulses roughly corresponded. What did you do to answer that question?

Dr. Barger. We took a map of Dealey Plaza and calculated a rough approximation using the mathematics of reflected, defracted and scattered sounds, the number of echoes that we thought would be loud enough to be audible over the noise of a motorcycle, an we found there would be about ten for a typical microphone location. Then we counted the number of impulses in each pattern of impulses that we see in the wave form records of the tape and we saw they were about ten. We realized there was still a possibility that these impulsive sounds that we saw in the record of the tape were in fact caused by gunfire.

Mr. Cornwell. At this point then you had devised six screening tests, any one of which I take it might have been sufficient to rule out these impulses as being gunshots and they in fact passed all six tests, is that correct?

Dr. Barger. Quite so.

Mr. Cornwell. Now, at this point did you have any conclusions or, on the other hand, did you feel that further testing was required?

Dr. Barger. At this point we felt we were justified in suggesting to the committee that a matched filter detection trial was warranted on the tape. As I said, the patterns that formed the basis or the match would have to be obtained by an acoustical reconstruction and the reason for suggesting that the matched filter procedure for detecting the event was, it is the most powerful method we know of with which to do that.

Mr. Cornwell. How about telling us in just plain, common language what you are referring to when you say an acoustical reconstruction?

Dr. Barger. The objective is to obtain echo patterns of the sort that I described briefly before and the purpose for having these patterns is to become the basis of the watch in the matched filter detector. In order to get these echo patterns, it was necesary to design a test that would get echo patterns that would in fact match with the event on a tape if in fact there were events on the tape that were gunfire.

Mr. Cornwell. In other words, you suggested to the committee they go back to Dealey Plaza and fire a rifle there so you could record it and see exactly what it looked like in that environment?

Dr. Barger. That is correct.

Mr. Cornwell. Before doing so, did you seek any independent opinion or consultation on this recommendation that you had made to the committee?

Dr. Barger. Yes, we did. I think the committee felt it would be wise for them to obtain a second opinion on the wisdom of conducting this test and in order to do that they obtained the agreement of professors Mark Weiss and Ernest Aschkenasy of Queens College to look at the results of our six screening tests that I just described and to look at our preliminary design for this echo pattern test or acoustical reconstruction and to form an opinion about whether they agreed with us that it was a reasonable and necesary thing to do.

Mr. Cornwell. For the record, Mr. Chairman, Professor Mark Weiss, whom Dr. Barger has just referred to, received a Bachelor of Electrical Engineering Degree from the City College of New York in 1952, and an M.S. in Electrical Engineering from Columbia in 1957. He has been a staff engineer at the Columbia University Electronics Research Laboratories and a Project Engineer and Vice President for Acoustics Research at the Federal Scientific Corporation. Currently, he is Professor of Computer Science at the Queens College in the City University of New York. Mr. Weiss has written numerous scientific articles and technical reports. He is a fellow of the Accoustical Society of America and a member of the Institute of Electrical and Electronics Engineering.

Mr. Weiss served on a panel of experts appointed to examine the Nixon-Watergate tape recordings during the Grand Jury investigation. The other individual Dr. Barger just referred to, Ernest Aschkenasy, received a Bachelor of Electrical Engineering Degree in 1967 and a Master of

Electrical Engineering Degree in 1972, both from the City College of New York. He has been involved in the analysis of enhancement of accoustic signals for over 10 years and was an associate professor with Professor Weiss in the examination of the White House tape record, in 1974. He is currently a senior research associate in the Department of Computer Science of Queens College.

Did Professor Weiss and Mr. Aschkenasy agree that testing from Dealey Plaza was a necessary and proper thing to do?

Dr. Barger. Yes.

Mr. Cornwell. After consultation with the authorities of Dallas, Texas, the committee, of course, ultimately agreed that you should conduct the testing. What problems did you focus upon at this point in time that you would face in designing and conducting a valid test?

Dr. Barger. If I may just make a comment before I answer that question, I remember something I was going to say before that I forgot.

In fact, I did not supervise the Judge Sirica panel that examined the tape recordings that President Nixon had. Dr. Richard Bolt, of BB&N, did that. I happened to have been director of one of the divisions of the company in which some of that work was done.

Now I remember your question, so I can answer it.

The first problem that had to be solved in designing the test was the fact that we didn't know where the motorcycle was, if, in fact, it was there at all. The second problem was, although we had evidence about the type of rifle used that was fired from the Texas School Book Depository, we had no evidence about the alleged weapon that might have been on the knoll. For example, we didn't even know whether it was a rifle or a pistol. The allegation didn't include that information.

We had to consider, also, where to put the targets at which to fire the bullets. As I have explained, the pattern of the end wave shed from the bullet is distinct, so the echo pattern at any one point depends upon the direction in which the rifle was pointing, as well as the place where it was fired from, and so we need to decide where, in fact, to fire the bullets. There was evidence the bullets, of course, had hit the limousine, the occupants in the limousine. There was evidence that a bullet had struck the curb on Main Street, down by the triple underpass, and there are the other indications by the presence of our impulses in the tape that there may have been a shot fired up near the corner of Houston and Elm, so we used those results to place the targets.

The next problem we had to figure out was what ammunition to use since the end waves are important. You have to have the muzzle velocity correct, and we needed to find ammunition that had a nearly similar muzzle velocity to that used by Oswald, or alleged to have been used by him.

We had to consider as a matter of practical significance the amount of time it would take to conduct the acoustical reconstruction. Requiring live ammunition as it did, of course people had to be secluded from the area, and that can only be done for a short period of time. We had also to accommodate the listening tests that were conducted by Dr. Green, and which he will describe later.

Mr. Cornwell. I show you now Exhibit F-337. I would ask you if you could use that exhibit to illustrate how you solved some of the various problems in setting up the test you have just mentioned.

Dr. Barger. Yes. This exhibit illustrates the positions of the microphone, the target and everything else.

Mr. Cornwell. Mr. Chairman, may we admit into evidence at this time Exhibit F-337?

The Chairman. Without objection, it may be entered into the record at this point.

[The information follows:]

********** INSERT **********

Dr. Barger. We positioned 12 microphones as an array of microphones in each of three positions: this group of 12; this group of 12; and this group of 12. The objective here was to cover all of the positions where the motorcycle may have been and still expected to hear the sounds of gunfire in a dense enough way so that the echo patterns received on adjacent microphones would not be so different that no match could ever be achieved should the motorcycle have been halfway between two of them.

The target locations we selected, based on the evidence I cited earlier, were here, number 4 here, target 3 at this point, and target 1 there.

Rifles were fired from here, as evidence indicates it was. A rifle and a pistol were fired from here as allegations have indicated there may have been.

Mr. Cornwell. When you say ''from here and from here,'' you were pointing at that Texas Schoolbook Depository as being where a rifle was fired from and the grassy knoll where both a pistol and a rifle were fired.

Dr. Barger. That is correct.

Mr. Cornwell. I would like to ask you now to look at Exhibit F-344 and tell us what this shows.

Dr. Barger. This shows a sequence of shots executed for each microphone array position in turn.

Mr. Cornwell. May we have Exhibit F-344 admitted into evidence, Mr. Chairman?

The Chairman. Without objection, it may be entered into the evidence.

[The information follows:]

*********** INSERT ***********

Dr. Barger. Here are shown the four target locations. The first rifle position was in the depository, with the muzzle of the rifle in the plane of the window.

Here the rifle was in the same position, but the muzzle was withdrawn two feet from the plane of the window. This was done because we had no clear evidence about where the muzzle, in fact, was relative to the plane of the window, and that small difference makes a noticeable difference in the loudness of the muzzle blast as perceived in the plaza.

The third location was from the knoll, apparently the rifle. The fourth was the knoll and the pistol.

The shot numbers here indicate the sequence in which the shots were fired and the absence of any number in any place indicates there was no corresponding shot fired.

Mr. Cornwell. Now, the numbers across the top where it says ''No. 1, No. 2, No. 3,'' what does that correspond to?

Dr. Barger. These correspond to the numbers of the targets, 1, 2, 3, 4, that were fired upon.

Mr. Cornwell. And the rifles which were used both from the window and from the grassy knoll were of what type?

Dr. Barger. I am sorry; I missed that.

Mr. Cornwell. The rifles which were used both from the Texas Schoolbook Depository and from the knoll were of what type?

Dr. Barger. They were both of the Mannlicher Carcano type.

Mr. Cornwell. And the pistol was of what type?

Dr. Barger. It was a 38-calibre pistol , of what manufacture I don't remember.

Mr. Cornwell. But the pistol would have been a subsonic weapon, is that correct?

Dr. Barger. It was chosen to have a subsonic missile; that is correct.

Mr. Cornwell. If we were to read Exhibits F-344 and F-337 together, would it be accurate to state that the sequence of shots in each array was perceived in numerical sequence for each array of microphones indicated on the plat of the plaza.

Dr. Barger. That is correct. The sequence indicated here was fired three times in repetition, once for each array location and each time ammunition of Norma manufacture was fired. The shot sequence was then repeated a fourth time when our recording equipment was recording the microphones in the third position, with Western Cartridge Company ammunition. This type of ammunition was of the same sort thought to have been used by Oswald.

Mr. Cornwell. Why were the first three arrays of 12 shots--actually, 11 shots with a rifle; one with a pistol--why were they fired with Norma ammunition instead of Western Cartridge Company?

Dr. Barger. I understand the Western Cartridge Company ammunition of this type is no longer manufactured and hard to obtain, and the committee could only get enough to fire through the sequence once; so Norma was used the rest of the time.

Mr. Cornwell. So at least the results could be compared to see if there was any substantial diffrence between Norma and Western Cartridge Company.

Dr. Barger. That is correct.

Mr. Cornwell. Now, I would like to direct your attention to Exhibits F-339, F-340, F-341, and F-342.

Dr. Barger. These are photographs that were taken during the period when we were setting up the acoustical reconstruction in Dallas.

Mr. Cornwell. May we have these four exhibits admitted into evidence, Mr. Chairman?

Dr. Barger. Without objection, they may be entered into evidence.

[The information follows:]

********** INSERT **********

Mr. Cornwell. This one shows a portion of Houston street, all of Elm Street. The yellow Xes on the street correspond to the position of the black dots on the previous exhibit and were where the microphones were placed. These sandbags that are observable here, barely observable here and there, are the first three of the four targets. The total number of sandbags available was insufficient to set up a fourth target simuyltaneously, so this pile of sandbags was transported to that location periodically.

Mr. Cornwell. So the sandbag targets 3 and 4 were moved back and forth, and you pointed to the place.

Dr. Barger. That is right. This photograph simply shows a ground level view of the microphones used to record the sounds at position 3, the sandbags with sand leaking out of them.

Here is a shot from the knoll, looking up at the microphones in array position 3, and the sandbags, and here the marksman and his assistant in the position where Oswald was thought to have fired.

Mr. Cornwell. The very last exhibit you made reference to, of course, was taken on the 6th floor of the Texas Schoolbook Depository before the test began, is that correct?

Dr. Barger. I am not sure when it was taken, but it was taken.

Mr. Cornwell. Let me ask you this. At least during the testing the windows were closed down to the way they were in photographs taken about the time of the assassination, is that correct?

Dr. Barger. That is a question I can testify about. It was known from the photographic evidence that during the period of the assassination the windows in the 6th floor were down with the exception of this one through which Oswald is thought to have fired, and it was half-way down, and so it was important to the accuracy of the reconstruction that all those windows be in that position exactly during the shots, and they were. However, it was a hot day, and the people in this room opened the windows between shots to air themselves out.

Mr. Cornwell. I now show you Exhibits F-358 and F-359.

Dr. Barger. These appear to be aerial photographs of Dealey Plaza that would be quite recent, because they include sevewral structures that were not there in 1963.

Mr. Cornwell. May we have those admitted into evidence, Mr. Chairman?

The Chairman. Without objection, they may be entered into evidence.

[The information follows:]

********** INSERT **********

Mr. Cornwell. There is simply one part of those exhibits I would like to direct your attention to, Dr. Barger, and that is the very large new hotel structure which would appear somewhat to the south of the plaza. Would you tell us whether or not that, of course, was there the day you did the testing?

Dr. Barger. The echo patterns that we expected to receive and did, in fact, receive had a maximum time span of one second. There were other echoes that came in at later times that were very weak, so weak that they were not considered in any of the matches and could not have occurred on the tape because they were so weak relative to the loud echoes.

The only echo patterns we ever needed or used were never longer than one second. The time required for sound to travel from the depository to that structure and back is a little more than three seconds. Since the interval between each test shot was much more than three seconds, the echoes from that remote structure had no effect on the matching process whatsoever.

Mr. Cornwell. You then have indicated that the large structure was present on the day you did the testing. It would not have been present, I take it, in 1963, but, nevertheless, it was so far removed from the plaza, it would not have affected in any manner the results of the test.

Dr. Barger. That is correct. It did not. The echo came in much later than any of the echo patterns that we used.

RPTR CANTOR

[11:30 a.m.]

Mr. Cornwell. What did you obtain from the testing?

Dr. Barger. As a result of the 4 sequences of 12-shot firings, we had 432 different test shot recordings on magnetic tape.

Mr. Cornwell. Were they of the quality that you had hoped? Did the equipment function properly, et cetera?

Dr. Barger. We monitored the recorded signals at the time that they were recorded to see if they were noise free and to see if they used the entire dynamic range of the recording system, in other words, to see that they were being recorded with the highest fidelity possible, and we observed for each of those records that we had achieved that. We did no other analysis of the records at that time.

Mr. Cornwell. I would like to now show you Exhibit F-338.

Dr. Barger. This exhibit is an illustration of the test patterns, and it shows 6 of them.

Mr. Cornwell. May we have Exhibit F-338 admitted into evidence, Mr. Chairman?

The Chairman. Without objection.

[The information follows:]

********** INSERT 3A **********

Dr. Barger. Here we show 6 echo patterns in alternate array. They were generated by Western Cartridge Company ammunition, which is somewhat incorrectly labeled here as Winchester ammunition, and then Norma for test shots fired from the repository with a muzzle 2 feet behind back of the plane of the window fired at target No. 3, received at microphones 7, 8 and 9 in array 3, namely, halfway down Elm Street, at microphone 9 we see, and all others we see, time plotted in the horizontal scale.

From here to here we have the total time span of one second. We have the intensity of sound in decibels plotted on the vertical scale in each of the 6 graphs. We see initially a very loud pair of impulses; if you look very closely, you see there are two of those. The first of those is the shock wave of the bullet passing overhead. The second of those is the reflection of the shock wave from the street just below the microphone. Then there are three rather distinct echoes and several others here that we can see if your eyes are very good.

The type of graphical data analysis here was on an ultraviolet recording, and it is hard to photograph, but here is the arrival of a muzzle blast. It coems later than the arrival of the shock wave because it is a supersonic bullet. Here is an echo in this case from the Records Building, and here almost 9/10 of a second later is the echo from the Post Office Annex which is across Dealey Plaza.

Now when you repeat that shot in every way except using Norma ammunition instead of Winchester, you see the same pattern. If you look at it in great detail, you find that the spacing between the shock wave and the muzzle blast using the Western ammunition versus that with the Norma is 5 percent greater. On the other hand, the bullet is 5 percent faster, giving a shock wave that occurs 5 percent sooner than the muzzle blast.

That is an inconsequential time difference to the matching process, and is certainly not evident when lookimg at these records just with the eye.

The similarity between these pairs of patterns, which differ only in the types of ammunition that were used, is very great, and thereby establishing that the substitution of Norma ammunition for the Western was an acceptable one.

As one looks down farther in the street, one sees that these patterns change somewhat. For example, the strength of the Post Office Annex echo is a little bit larger at microphone 9 than it is at microphone 7, as an example.

Mr. Cornwell. And after determining that your test had gone well, that you got the type of data you were looking for, and that there was no substantial differences that would affect the validity of the test, depending on whether you used Norma or Western ammunition, what did you do next?

Dr. Barger. The next project then was to begin the comparison of the test patterns with the police tape. Let me describe the process of doing this now.

We first divided the motorcycle tape into segments, each containing at least one of those patterns of impulses that we were testing for the possibility that they were caused by gunfire.

We then matched each of these 432 echo patterns that are examplified by that exhibit with each of those 6 segments of the tape. Those 6 segments that we analyzed comprised the entire part of the record of the Dallas police tape that passed the 6 screening tests that I decribed.

The procedure for conducting this match is a mathematical one, and it is known as a correlation. The type of correlation that we used is a binary correlation, and this is a decription of a fairly simply process, which I will now attempt to make entirely clear.

The echo patterns were each examined to find the loudest echoes thereon, and some patterns had 5, others 15. Any one that was loud enough to exceed the threshold of audibility was accepted.

Then each of the 6 segments of the tape were examined, after having presented them in the same way, loudness in decibels on the vertical scale, and time on the horizontal scale. Those records were initially made at a horizontal scale of 16 inches as equal to 1 second.

Once those 6 segments of the tape had been thus prepared, they were simiarly thresholded, and I will illustrate this more graphically in a minute, to determine all of the impulses on each that exceeded a threshold, and they were numbered, and their location in time was noted.

Now the design of the test included the feature that each microphone was 18 feet from the next, and so it is possible that the motorcycle was halfway between 2 microphones, so a microphone could at worst be 9 feet from the motorcyle if in fact there was a motorcycle present. That means that there is at least a 9-foot uncertainty in the location of the microphone in respect to where the motorcycle may have been at each time that we are examining.

This was accommodated by adding an uncertainty window 6 milliseconds on either side of each impulse found in the Dallas tape. In other words, each impulse was considered to be 12 milliseconds wide, so as to fall anywhere that it might have been if the motorcycle had been in fact anywhere it could have been with respect to any one microphone.

Having prepared the echo pattern and the impulse pattern from the tape in that way, the correlation was performed as follows: The two patterns which were all test-shot patterns were compared to all impulse patterns on the tape for a total of about 3600 possible correlations. The correlation coefficient was calculated for each match, and this coeficient was calculated as follows:

The number of coincidences between impulses and echoes was the numerator, and the denominator was the square root of the product of the number of echoes by the number of impulses. If 2 patterns perfectly matched in this way, the cross-correlation coefficient that you obtained would be equal to unity. If they only matched at one point and no other, it would be 1-to-10 or elss. The bigger the value of the correlation coefficient, the better the match.

Mr. Cornwell. The closer, in other words, that the number, which would be in percentages, point something approaches one, the better the match?

Dr. Barger. That is correct. That was the procedure.

Now once that was done, we had a big pail full of 2600 numbers, and we exhibited to ourselves then for the first time on the blackboard all of those numbers that were larger than a threshold value, which was set at .6. I will describe the reason for that in a moment.

From this time on, I will mostly talk about those matches that exceeded a correlation coefficient of .6.

Mr. Cornwell. I would like to show you Exhibit F-347, and ask you if you would tell us what that is.

Dr. Barger. This illustrates 2 types of data. Here are 3 test patterns. These 3 test patterns were generated by a shot from the depository with the muzzle 2 feet behind the plane of the window fired at the target number 1, which was located just at the head of Elm Street in a position previously described, and it was received by microphones 4, 5 and 6 in the array positions.

Those microphones were on Houston near Elm, and we see in each of these that the first sound that arrived was the muzzle blast. There is no shock wave that precedes the muzzle blast, and that is to be expected because in this case the shot is fired in this direction, and the micropone is over here, and according to the first exhibit I showed, the shock wave would not be seen 90 degrees laterally.

As you look at the arrival of the muzzle blast, you see that in each channel it occurs progressively later in time, so if you connect the peaks, they slant. This is because channel 4 microphone is farther away from the rifle than channel 5 and channel 6 microphone. However, if you look at these peaks out here near one second, these are the echoes from the Post Office Annex.

As the microphone moves away from the source of the rifle, the location of the rifle, it is moving toward the Post Office Annex. Therefore, the echo in fact comes in sooner, so when you connect the dots signifying each of those echoes, they have a slope in this direction.

One selects all of the significant impulses on these test patterns. We have placed dots on them. Some of the dots are obscured in these dark areas where the photographer has overexposed them, but nevertheless, they are there, and we have connected all of those that we think are caused by the same echo-generating device by line, to show how the time that that echo arrives is changing contuously as you move the position of the receiver.

Up here is shown a portion, a segment, the Dallas police tape that was also prepared at the same time scale, 16 inches equals a second with intensity vertical on the scale in decibels, and the threshold has been made, and all of those impulses that exceeded have been identified and nmbered, and the plus or minus 6 milliseconds acceptance regions have been marked, these to accommodate the uncertainty of the exact position of the motorcycle.

I knew that when--I am not prepared to show how this echo pattern matches the test pattern--and I knew I would probably forget which one it is that matches with it, but it is quite evident. If you tried to match this pattern with this shot, the significant impulses at this point would not in fact match with the significant impulses in this pattern, even though with this setting the echo from the Post Office Annex does.

However, if you match it with the test impulse obtained at channel 5, which is a different place, then they match quite admirably in fact. If you count the dots signifying significant echoes in the echo pattern with the marks signififying the significant impulses in the Dallas tape, you find there are 12 matches out of 17 possible impulses, and if you count these, 15 possible echoes. The cross-correlation coefficient for that match is .75.

Mr. Cornwell. Given the amount of noise in the Dallas Police Department tape, would you expect that you would ever get a complete match, all 17 out of 17 in this case?

Dr. Barger. Many of the impulses on the tape, on the Dallas police tape, this segment of it in particular, that correspond to the total number that were above the threshold value of 17 are caused undoubtedly by nonacoustical events, such as the key intransigence that I described when I was showing the results of the spectrographic analysis.

However, none of those impulses in this particular segment of the tape have been inclusively identified as being any of those, so the noise from whatever its origin that is present in the police recording tape, there is demonstrably noise there, in addition to any impulses that may be caused by gunfire, those would rise up and compete with the impulses caused by gunfire and reduce the value of the correlation coefficient to some number less than one.

Mr. Cornwell. So in spite of the fact that the correlation coefficient was not one, the match was not perfect, your words were that this was a quite adequate match. In other words, it had a correlation coefficient which approximated one, is that correct?

Dr. Barger. Well, it was not possible to reach that judgment by looking at one alone. We looked at 2600 of them, and reached our conclusions from that. This was to illustrate just one.

Mr. Cornwell. Now I believe, Mr. Chairman, we forgot to ask that that last exhibit be admitted into evidence. May we do so at this time?

The Chairman. Without objection, it may be entered into the evidence at this time.

[The information follows:]

*********** INSERT 3B **********

Mr. Cornwell. I would now like to direct your attention to Exhibit F-367, and for your assistance ask that F-367 and F-348 be placed up there simultaneously.

Dr. Barger. Yes. This one and this one have been introduced as evidence. This is new.

Mr. Cornwell. Would you tell us what F-367 is?

Dr. Barger. It is a list of those 15 matches of the 2600 approximate matches we attempted that did in fact exhibit a correlation coefficient higher than .6.

Mr. Cornwell. May we have Exhibit F-367 admitted into evidence, Mr. Chairman?

The Chairman. Without objection, it may be entered into the evidence. [The information follows:]

********** INSERT 3C **********

Dr. Barger. Very well. There are 15 descriptors here. Each one describes a case where an acoustical test pattern matched better than the threshold value of .6 with a segment of the Dallas tape.

The first sitution where this occurred I will label with blue. There were 4 test patterns that corresponded with the segment of the tape that began at 137.7 seconds after the stuck button, with coefficient, correlation coefficient, larger than .6, and these are the 4, and I will note with a 1 that that is the first time in the tape that any of the test patterns correlated with any of the impulse patterns in the police tape with a score better than .6, and have the 4 times.

Mr. Cornwell. So at that point you are telling us that there is a segment of the Dallas police tape which very closely approximates or at least has a correlation coefficient of over .6 with respect to various of the test shots?

Dr. Barger. Yes. This section may contain the sound of gunfire. Then going on down in the list, we have wha t I will label the second time, the second place on the Dallas tape, where correlations or matches were achieved that were good enough to exceed the threshold value, and I will label that with a red, and there were 5.

Then in the same way at a later time, around 145.15 seconds, in green, I will label and highlight in fact the 3 test shot patterns that correlated with that part of the tape better than .6. Finally, at 145--yellow is not the best, is it--well, in the absence of being able to see anything representing the fourth part of the tape when there was a time at 145.61 seconds when three different test patterns achieved the correlation score greater than .6.

Let me rummage through my briefcase and see if I can find another color. Black is the obvious choice.

Now a feature of a detection of a receiver that was designed to detect the possibility of otherwise subaudible events by using the correlation procedure can give threshold exceedences under two circumstanes. One, it exceeds the threshold when it has correctly detected the event, and the other is, it exceeds the threshold when it has incorrectly detected the event. The latter circumstance is called a false alarm.

It is the purpose of my testimony to examine the question of which, if any, are false alarms.

Mr. Cornwell. Before you do that, I take it that you took each of the four segments of the Dallas Police Department tape, which you have indicated with the numbers one, two, three and four, and compared them with all of the test patterns, and what you have simply illustrated on the chart is a match very similar to the one that you showed us physically how you performed earlier with respect to a shot in the first time frame. Is that correct?

Dr. Barger. That is correct.

Mr. Cornwell. Then would you use the exhibits which are presently emplaced and tell us what that means in terms of the other diagrams as to the location of the microphones and the direction and location of the shots.

Dr. Barger. I can say a few preliminary things about that with these exhibits, a few preliminary things. The results suggest that there are detections at four different times of day.

If the motorcycle were in Dealey Plaza, it would only be in one place at each of those times of day and would either be standing still or moving in some reasonable pattern.

The fact that the correlations achieved or the matches achieved at the first time on the tape when any matches were achieved are achieved either at microphone five or six in array position, and there is five and there is six would mean that at the particular time of day associated with this time on the tape, we would so far tentatively estimate that the motorcycle was there.

Mr. Cornwell. Let me show you at this point then Exhibit 370, and ask you if you would tell us what that is. Could we put the two exhibits, the latest one, 370, over next----

Dr. Barger. This would best be in this position I think, thank you. We want to examine now the meaning of these detections that passed the threshold level to see if there is any reason to believe that they are not all false alarms, possibly. I will attempt it in this way.

At the first time of day that we saw any matches whatsoever was at this time which I have labeled blue. The indication is internally fairly consistent, and it indicates that the location of the microphone at that time is between array five and six.

So I put a blue dot there because that location was derived from the matches made at the first time of day at which any matches were made, and then I will begin to construct a plot.

It would be best if I could draw this for you and you didn't see what is already on there before I start, but if you will attempt to follow the pointer, I am going to plot here time of day with zero representing the time that this first occurrence was observed, and I am going to plot the distance down the motorcade route along the vertical scale as measured from the position of the motorcycle at that time.

In other words, ten feet down the motorcade route, 20, 30, 40, 50, all the way down to here would be 250 feet.

I will signify that I mean at zero time and at zero distance that were here by that blue circle. In other words, at this time we are here, and I am going to describe that position as zero distance down the motorcade route, and that time as zero time on this scale.

Congressman Fithian, will you let me get away with that? Shall I proceed? Very well.

At the second time of day when there were any correlations achieved that did in fact exceed the threshold, which I have labeled red, then we see that the motorcycle--well, let me point out that the time difference between these two occurrences is 1.6 seconds, so we plot 1.6 seconds later the position of each of the microphones that are correlating with that sound on the tape.

In other words, at that time, 1.6 seconds, all of the microphones were not right here in one area as they were at the first time. Some of them were up the street.

So I will simply mark in red this is the time on this scale that corresponds to this time of this pattern, but I can't make a nice, little circle yet because they are all over the place. There must be some false alarms in there.

Now, at the third time we have green as an indication. Green occurs at this time seven and a half seconds after the time of the first one, which was indicated by blue.

At the time of the green, the green part of the Dallas tape, we had three detections, three matches--one here, one here, one here.

All those are not all in the same place and the motorcycle can only be at one place at the green time, as well as it can be only at one place at any other time, so there is a little bit of ambiguity there, but let's press on.

At the next time, which is a half a second later, which would be indicated by the black time, which is eight seconds approximately after the first one, we notice that the position of the microphone that gathered the test pattern that gave the correlation that passed the threshold was here, here and here.

All right, so now explain where those 15 dots come from. Those 15 dots represent these 15 correlations that passed the threshold of .6, and they are illustrated as a function of the time that they occurred and the position down the street where the microphone was that picked up the test pattern that gave the correlation in fact.

Now, we have to look at these and immediately see the motorcycle can't be all over the place, but there is a high degree of order in this diagram. The negative hypothesis--am I supposed to be quiet while that happens?

The negative hypothesis would be that the motorcycle was not in Dealey Plaza. If that were true, then this scale that describes the distance down the street of the motorcade would be meaningless in the data, and the data would occur in time and in distance down the street at random.

But the eye can see that they tend to follow a sloping line. It can particularly see that because of these prior lines that I drew in, and that is what I was suggesting might have better not occurred.

There is a lot of order in the occurrence of these 15 correlations.

Now, how much order? Well, if one segments the position of motorcycles down the street into four bins or four compartments, and segments the time at which they occurred into four compartments which are naturally the four compartments into which the data are segmented, then one has to question what is the likelihood that this order pattern could have occurred by chance; in other words, was it the likelihood this pattern would have occurred if the motorcycle wasn't there.

There is a test for that sort of thing, and it is called the Chi square test, which if you segment the data into four times and four places, as I have done, it is a test done with nine degrees of freedom, and you calculate the Chi squared value which is a measure of orderliness and you get 17-1/2 for those of you that have tables of the Chi square distribution.

The meaning of that number is this much order would occur only five times--well, let me make sure of this. This amount of order would not occur except five times out of 100 if this was caused by chance.

In other words, if the motorcycle was not there and the data were distributed at random, there is only a 5 percent chance that that would have occurred. This much order in the data would occur, be expected to occur, 95 percent of the time.

That is just about at the level of the statistical significance that gives the person confidence that there are correct detections in the data. On the other hand, there are demonstrably also false alarms.

This can be seen by observing that if some of those curriculi in fact indicate the position of the motorcycle, then some of them must be wrong becuase the motorcycle can't be in two places at ones.

Mr. Cornwell, I could proceed with what I am doing now or we could put up those other three. I think it might be easier if I proceed.

Mr. Cornwell. Go right ahead and proceed.

Dr. Barger. It is now the task of the committee and me to try to identify to the best we can which of these detections are false alarms and which ones are not. We have a good deal of confidence that many of them are not.

Now, in order that the motorcycle could achieve this position 130 feet down the street from the blue position in the 1.6 seconds it would have to go 100 miles an hour.

There is no evidence to indicate that it did that, and so this particular detection is labeled a false alarm. It couldn't be true. It leaked through because we lowered our threshold of detection to the point where we had enough correlations so we could be reasonably certain that the true answers would emerge. We wouldn't want to shut them out.

Now, if you assume that the trajectory of the motorcycle is from the blue position, at which we can be reasonably confident through these, the slope of that line is 11 miles an hour. That is approximately the speed of the motorcade.

If one said, perhaps these are false alarms and that is the correct trajector of the motorcycle, in that case the motorcycle would be going 18 miles an hour approximately. It would be going from behind the limousine--I mean, 120 feet behind the limousine and drawing close to it. I had better explain what I mean by that right now.

If we assume that one of these last two occurrences represents the so-called head shot, then we know at that time where the limousine was. It was at frame 313. Frame 313 is 250 feet down the street from the blue dot, so 250 feet at that time of occurrence is here, so this must be where the limousine was at that time.

It was going at about 11 miles an hour as determined by photographic evidence. If one plots back at 11 miles an hour, one finds at the time of the first occurrence the limousine was somewhere 120 feet ahead of the motorcycle, which would have put it right there.

Now, again, I am examining the question about whether these three or these three are candidates for false alarms. If these three are truth, then the motorcycle was going 18 miles an hour, catching up with the limousine, and in fact having achieved a position only 40 or 50 feet behind it at the time of the head shot.

Now, if you recall the first thing we noticed on the tape was that there was a dimunition of the sound due to the motorcycle three seconds prior to the first impulsive pattern that we originally suspected could conceivably be caused by gunfire.

There was no obvious explanation for that, until one sees that at that atime he was just beginning a 100 degree turn, and on the inside track apparently, and he would therefore have to slow down to execute the turn.

Now, it was further observed that the motorcycle sound stayed diminished after the turn. It did not increase to the level that it had formerly been. Therefore, it would seem that it couldn't have increased speed, which it would have had to do to achieve this position in eight seconds.

If, on the other hand, it had continued at the same speed of the motorcade, it would have achieved this position in that time.

There is, therefore, that sound of the motorcycle evidence that indicates that these are false alarms. Now, that is an example of a kind of corroborating or disqualifying evidence that is of practically nonacoustical origin, although I must say we are infering that the motorcycle didn't speed up because the noise didn't increase, that can be used to identify one of these detections that we have accepted about lowering the threshold sufficiently to be certain to catch the correct detections, and to label them as false alarms.

In other words, indications of detection that were accepted by the test, but that can be shown by other reasons not to be possible and, therefore, to be false alarms.

As a result of that judgment, the estimate of the motorcycle position at the time of the second impulse, the red one, would be there, which is right there, and the estimated position then of the motorcycle at the time of the third occurrence, which is here, is right there.

I lost my graphical symbolism a little, and that is right there, and at the time of the last segment labeled four, which at this time we would estimate it to be halfway between those two right there, and that is there, 120 feet behind the limousine at the time of the head shot, if in fact these impulses represent the sound of the head shot.

There is the possibility of labeling one of these four threshold crossings as a potential false alarm because it involves firing from this place at this target at the time that the limousine was here.

That is almost 180 degrees out. It is inconceivable that anyone would do that, and on that basis one of these can be judged a false alarm.

The fact that some of those are thought to be correct detections was illustrated by all of the order in the data, as I explained earlier.

Mr. Cornwell. Dr. Barger, does that conclude your descriptionof the analysis that you performed?

Dr. Barger. Yes, it does.

Mr. Cornwell. Let me then ask you in sum, is it fair and accurate to state that after all of the analysis there is evidence of four shots on the Dallas Police Department tape, and that the acoustical sounds that may represent those shots are spaced as follows: between the first and second approximately 1.6 seconds, between the second and third approximately 5.9 seconds, and between the third and fourth approximately five-tenths of a second?

Dr. Barger. Yes, that is a possible conclusion.

Mr. Cornwell. I have no further questions. Thank you.

The Chairman. Thank you very much.

Doctor, I would just like to say you are a fascinating teacher. I am just glad I don't have to take a test on what you have taught us here.

May I consult with the committee for just a moment regarding recessing at this time.

At this time the committee will recess until 1:30 p.m. this afternoon.

[Whereupon, at 12:15 p.m., the committee recessed, to reconvene at 1:30 p.m., the same day.]

RPTR CANTOR

AFTERNOON SESSION

[1:50 p.m.]

The Chairman. The committee will come to order.

The procedure this afternoon will be for the Chair to, firstly, recognize the gentleman from Indiana, Mr. Fithian, who will be permitted to consume such time as he may need in order to fully and extensively question the witness. After that, the Chair will operate under the 5-minute rule as to other members of the committee.

The Chair at this time recognizes the gentleman from Indiana, Mr. Fithian.

Mr. Fithian. Thank you, Mr. Chairman.

Dr. Barger, we want to thank you for your excellent, very technical, and very complete testimony this morning. And as you must be aware, this poses as very serious evidence for us in that it does not corroborate some other evidence that we have.

And I want to go back now, so that I am clear and others in the room are clear, as to just what it was that you set out to ascertain by the tests that you ran in Dallas when you went back and sort of recreated the shot pattern.

What was it that you were specifically trying to do?

TESTIMONY OF JAMES E. BARGER [RESUMED]

Dr. Barger. Congressman Fithian, the first thing that we sought to do was to determine if there were any sounds of gunfire in Dealey Plaza that were recorded on that tape. In other words, we were seeking to determine if the motorcycle, whose stuck transmitter was transmitting sound, was in fact in Dealey Plaza.

Mr. Fithian. So you are trying to actually locate the motorcycle itself?

Dr. Barger. It became necessary, first, to determine if the motorcycle was in Dealey Plaza, and then to locate it therein.

Mr. Fithian. And as to its location, correct me if I am wrong, you set your microphone 18 feet apart?

Dr. Barger. That is correct.

Mr. Fithian. And you did this from the beginning of the turn on to Houston, down Houston to the turn on Elm Street, and down Elm Street, at least as far as where the ZSapruder film showed, the head shot of the President?

Dr. Barger. That is correct.

Mr. Fithian. Now does this mean, to those of us who are laymen, that once you locate a match of echo patterns, you have physically located the motorcycle to somewhere within that 18-foot stretch?

Dr. Barger. That is correct. The echo patterns depend for their structure on the location of the microphone that receives the sound, and so we accepted, or I should say we sought matches of the echo pattern that were sufficiently precise to represent a motorcycle microphone located within approximately 9 feet of each of the microphones.

Mr. Fithian. And then you presumed that the motorcycle was moving at the speed of the motorcade, or roughly that?

Dr. Barger. We presumed nothing about the location of the motorcycle or its speed or even direction of motion. The matches were made without any presumption whatsoever about the position of the motorcycle, in fact, of course, without any knowledge that the motorcycle was even there.

After having made the matches, however, the position, I should say, the location of the microphones through which we found matches did in fact progress down the motorcade route at the times that the four subsequent periods on the tape showed matches. And as I indicated previously, the locations of the microphones where the matches were found at the four different times were moving down the motorcade route at approximately 11 miles an hour.

Mr. Fithian. And the number of microphones you used then determined by what, by the uncertainty of where or if the motorcycle was there?

Dr. Barger. We started out with no assumption about where the motorcycle was, other than the fact that it was presumed to be on the street along the motorcade route. Therefore, we wished to put microphones all along the route in Dealey Plaza. It was very difficult for us to record through more than 12 microphones at one time, and so in fact we did record through only 12 microphones at one time. It was rather time consuming to conduct a full round of test shots considering the need for observing safety precautions and the like. And so in order to conduct the entire test within a morning, we calculated that about 36 microphone locations could be accommodated and this indicated an 18-foot spacing.

The 18-foot spacing was judged adequate because it would place the motorcycle no more than 9 feet from the nearest microphone. That dimension is about half the width of the street. So if we put the microphone in the center of the street, even though the motorcycle was at the curb, we would be within that 9 feet.

The time it takes sound to travel 9 feet is 9 milliseconds. That is a fairly short period of time. We judged that small uncertainty, 9 milliseconds, to be adequately small compared with the total time over which the echoes would arrive, that being almost a thousand milliseconds or 1 second. That is the way that we decided upon the 18-foot spacing, the desire to have a small enough error, possible error, due to uncertainty of the true motorcycle location and the desire not to conduct the test all day long.

Mr. Fithian. Then are you satisfied that the fixes, if we can use that term, of the motorcycle that you came up with, are within 8 to 10 feet, or something not much greater than half the distance between one microphone and another?

Dr. Barger. Yes, yes, I am satisfied that the 18-foot spacing was not too coarse.

Mr. Fithian. Now to the layman, it would seem that if you are going to recreate a test, that you might have wanted to use instead of the most modern microphone equipment, you might have wanted to use, as nearly as you could find, microphones and transmitters identical to those which you believed to have been on the original motorcycle. And I would like some explanation as to why you chose not to use the motorcycle microphone, which you have indicated at one point in your testimony you had indeed used, from the Massachusetts police. Evidently that kind of a microphone or transmitter is available.

Why then did you use a more sophisticated system of microphones?

Dr. Barger. A more sophisticated system?

Mr. Fithian. Yes, more sophisticated than obviously was on the stuck transmitter.

Dr. Barger. Why did we use the more sophisticated?

Mr. Fithian. Why did you?

Dr. Barger. There are two reasons. In the first place, as I showed, the radio distorts and limits the amplitude of loud sounds. Each radio does that in detail in a different way. We weren't seeking to look at the waveform of each sound echo, only the time at which it occurred. The radio does not distort the time at which it occurs, nor does the more sophisticated equipment that we used.

The more sophisticated equipment that we used is known to be reliable and not to fail in times of stress in the middle of a sensitive test. Old motorcycle radios from those earlier days are known not to be very reliable, nor are they to be found in the quantities that we required. Therefore we selected a system that would give us equivalent data but more reliably.

Mr. Fithian. So that I understand now, the data that you were really looking for was not dependent upon the amplitude or the height of the blip, or whatever you want to call it, greater than a certain amount, which would help you identify. Rather you were trying to locate it along the time line?

Dr. Barger. Correct. That is absolutely correct.

Mr. Fithian. As I understand it, Mr. Chairman, this committee employed two other specialists that Mr. Cornwell referred to this morning, Mark Weiss and Earnest Aschkensay, and you went over the plan of the test with them; is that correct?

Dr. Barger. That is correct.

Mr. Fithian. Did they concur in the layout of the array of microphones, the type of microphones? In other words, did they concur in your proposed test plan?

Dr. Barger. They did.

Mr. Fithian. Tell me then something about the difference in the status of the science of acoutics from 1964, when presumably this tape was in existence and could have been analyzed and 1978 when you analyzed it, 1977-78 when you analyzed it, not in great specificity. But what are the grand changes that have taken place in that 14-year period?

Dr. Barger. Well, there are two. First, the adaptive filter that we used to reduce the level of the motorcycle tape was a procedure that was not then, had not then, been worked out. It was not known.

Secondly, the method we used to detect for the possibility, to search for the possibility of sounds, is generally called a matched filter or a matched detector.

The theory of that device, that method of seeking the presence of suspected signals in loud noise, was developed principally I believe by the radar community during World War II. It was therefore known in 1963 to people who study the process of detecting expected signals imbedded in loud noise.

The community that shared that knowledge in 1963 was not as wide as it is now. I don't believe I knew about it then.

Mr. Fithian. But the filtering process that you used came in, I think you said this morning, in 1968 to 1970; is that correct?

Dr. Barger. Well, probably more like '66 to '68, but, that is correct.

Mr. Fithian. Now some of the terms you used this morning I am sure must be every day terms to you, but I am not sure all of us followed those.

One of the key terms seemed to be ''impulsive events'' or ''sequence of impulsive events'' or something to that effect.

What does that term mean, to those of us who don't get along very well with this science?

Dr. Barger. I used the term ''impulsive event'' to describe the brief, loud bursts of noise that appeared on the Dallas police tape.

Now when I listened to the tape, you hear spits and stutters and pops. Those would all be descriptors of impulsive acoustical events. When you look at the waveform as presented on the oscillograph records that I showed, then the transient events are characterized by short intervals of time in which the loudest of a sound is rather intense so it looks like blips or peaks in the amplitude record.

Mr. Fithian. And another term that was used, I think, as you took that concept and tried to transfer it to the visual, was spectrographic analysis of this transient event. I take it that is that chart that you put up on the wall this morning?

Dr. Barger. Yes, I did put--we did have an exhibit that was a spectrographic analysis of a segment of the tape recording; that is correct.

Would you like me to discuss that briefly?

Mr. Fithian. I just wanted to make sure my understanding was correct, and, that is, that the spectrographic analysis is sort of a visual playout of this grassy looking material that is blips and depressions.

Dr. Barger. Yes. The spectrogram itself is a visual description of the tonal content, frequency content, pitch content of sound as a function of time. In other words, if a person was raising his voice like that, you would see a diagonal line on the spectrogram, indicating as time progressed, the pitch of the sound was rising.

Mr. Fithian. And now the adaptive filter you used, do I understand that correctly, that is the process of filtering out noises and things that you don't want to measure?

Dr. Barger. The adaptive filtering process, which I characterized as a Woodrow-type adaptive filter was used because it is effective in reducing repetitive noises, not impulsive noises, but repetitive ones. If you listen to a motorcycle, basically you hear the sounds of the cylinders firing, and they fire at idle of that motorcycle about once every 140 milliseconds. So, therefore, the noise generated by that motor cycle has a tendency to resemble itself every 140 milliseconds later.

The adaptive filter studies that noise, determines what is expected to occur in the future, subtracts that out from the data that is just coming in, and leaves you with the absence of that repetitive noise, which if you are looking for transient events or impulses about which the filter could have no prior knowledge, because they only occur once, then that fiter leaves you with those transients more clearly observable. The noises, in other word, the repetitive noise that was masking those transients is thus reduced.

Mr. Fithian. And one final sort of terminology question. You used the term ''match filter technique,'' ''matching filter techniques''----

Dr. Barger. Yes.

Mr. Fithian. ----and that means what?

Dr. Barger. That means that you have in your--you expect to receive one of many kinds of signals. By ''many kinds,'' I mean a signal in this case that has a series of impulses that occur in a definite sequence, like, let's say, the first one occurs at a particular time, the second one perhaps 3 milliseconds later, the third one maybe 15, the fourth one 27, the fifth one 12-1/2 after that, and so on, a definite sequence of impulses.

We went to Dallas to find out what the sequence of impulses would be that would be generated by Dealey Plaza if a gun was fired.

Having found out what that sequence of impulses is, you then go through the tape in question and look for sequences of impulses that match it. When you find one that matches it, you say aha, at that time something occurred that generated a pattern of transient events that just matches what we did in Dealey Plaza, and when that occurs, you judge that you have made a detection. You have identified a similar source of noise. The word ''matched filter'' is really technically correct or often used form, and the use of the word ''match'' is fairly self-evident, I believe.

Mr. Fithian. Now I am sure there must have been a reason for your lengthy analysis of this bell tone. I am not sure that--I guess my question is why did you look for and analyze and worry about the bell tone, since we were looking for some kind of rifle shots or pistol shots or whatever?

Dr. Barger. There are two reasons. First, we wanted to see if in fact there were any sounds on the tape that were caused by acoustical signals such as a bell would generate and found that that period that sounded like a bell was a bell.

Secondly, we hoped to establish, we hoped to learn, where that bell really was and had thought if we could find it, we would then know where at least one microphone was that was transmitting on Channel 1 at that time.

Mr. Fithian. So, you were trying to verify that there were transmittals on that tape?

Dr. Barger. That there were acoustical events as opposed to what might be called microphonics. In other words, as you take a radio transmitter and just kick it around and shake it, as a motorcycle might do, particularly if the radio were broken, then it would transmit signals that wouldn't have any bearing due to sounds. We just wanted to see if there were sounds on there.

Mr. Fithian. Now, I am not sure, counsel, what the exhibit numbers are, but I am interested in the way you went about locating the targets; that is, physically locating the targets that you were going to fire at.

I understand why you selected the two points from which you fired, but could you put up the three or four photographs of Dealey Plaza, F-367 and F-377?

Mr. Cornwell. F-337 and F-344, I believe.

Mr. Fithian. While they are doing that, let me ask you sort of the central question.

Is it your conclusion that you proved that there were four shots?

Dr. Barger. No.

Mr. Fithian. With regard to the groupings of shots, what do you prove then?

Dr. Barger. As regards the grouping of the shots, we demonstrated with high confidence that if there are four shots, we demonstrated the times at which they occurred, and the intervals between them were described by Mr. Cornwell, 1.6 seconds, was it 5.9, and 0.5.

Mr. Fithian. Would you repeat that again, please?

Dr. Barger. Yes.

Mr. Fithian. The distance, the time frame between the first and the second shot is what?

Dr. Barger. 1.6 seconds.

Mr. Fithian. And between the second and what you perceived to be a possible third shot?

Dr. Barger. 5.9.

Mr. Fithian. And between the possible third and the possible fourth shot?

Dr. Barger. 0.5.

Mr. Fithian. 0.5?

Dr. Barger. 0.5, one-half second.

Mr. Fithian. One-half second. So what you are saying, Doctor, is that if there were shots fired, they came at those intervals?

Dr. Barger. Yes.

Mr. Fithian. And let's hypothesize for a minute. If there were only three shots fired, how do you account for the disturbance that you find at I guess it would be 5.9 after the first shot--after the second shot, I am sorry.

Dr. Barger. I don't have the best exhibit in front of me to answer that, but let me do it without, for the first time. Of the 15 detections that our matching process achieved, ten of them cannot be discounted as false alarms.

It would be necessary for at least three of those to be correct detections, to have established the coherence in the data that led to our conclusion that the microphone was in fact in Dealey Plaza.

It is therefore likely that somewhere between three and six of the remaining ten are also false alarms. Therefore, anyone----

Mr. Fithian. May I interrupt just a moment?

Dr. Barger. Yes, of course.

Mr. Fithian. I think the staff was putting up the right pictures. I wanted the big pictures of Dealey Plaza. I think there are three or four of them altogether. You had three of them out just a moment ago. Go ahead, Doctor.

Dr. Barger. Therefore, it would be unreasonable to expect that on the orders of approximately five of the remaining ten detections were also false alarms, but there were ten.

That would indicate that about half of the detections that I did not previously indicate to be false alarms, about half the remaining ten, are false alarms, which would indicate that the probability that each one is a correct detection is about a half.

Mr. Fithian. I am going to return to this a little bit later. I am going to put those microphone images up there and we are going to go through that time frame because it is very important to me, but right now I want to try to establish the location of the targets.

Now, I am not at all interested in the charts right at the moment. I just want the pictures, the two pictures you have plus another one that shows some interstate signs with targets behind them. That is the particular one I want.

Dr. Barger. Well, it is there.

Mr. Fithian. Yes, okay. Set it up on the upper easel if you will. Thank you.

Now, could you put on your half a Lear microphone, Doctor, and I would like for you to locate for us again the locations of the targets that they fired at.

Dr. Barger. Yes. The target that was illustrated as target location number one is this pile of sandbags right here.

Mr. Fithian. And let me just make sure my optical illusion isn't getting away from me. That is between the Texas School Book Depository wondow on the left and the interstate signs overhead, is that correct?

Dr. Barger. This picture is taken from the window adjacent to the window from which Oswald is thought to have fired, so it is taken from the depository.

Mr. Fithian. So that one you are pointing at is up the hill, if you will. It is lcoated in the road prior if you are going towards the underpass, prior to arriving at the interstate signs, the first target that you just had pointed at down here, just right there.

Dr. Barger. Yes.

Mr. Fithian. That is physically before you get to the interstate signs.

Dr. Barger. These signs?

Mr. Fithian. Yes.

Dr. Barger. Well, it is physically just before them, that is correct.

Mr. Fithian. And the second target is where?

Dr. Barger. The second target is hiding behind the trees right at that point.

Mr. Fithian. The third target is the one down the road?

Dr. Barger. That is the third target.

Mr. Fithian. Now, in the location of targets, are those, as nearly as you can compute from the Zapruder film or otherwise, the exact location of the President and Governor Connally in the limousine?

Dr. Barger. No. With regard to the target three, which was positioned to be at the same place as the limousine in frame 313, that was put in that place as well as we could determine it.

Mr. Fithian. And is target one in the same location that you presumed the first shot was fired?

Dr. Barger. Of course, I don't know exactly where the limousine was when the first shot was fired.

Mr. Fithian. I guess basically I am asking you why did you locate the target there?

Dr. Barger. As I recall, we sought to place the first target at about the position of the limousine, at about frame 160. The reason for that was that the preliminary screening that I described earlier of the impulses on the tape indicated that if the first pattern of impulses that could be seen occurred, oh, well, prior to frame 313 by enough time that, as I recall, brought it back to about frame 158. That is why we tried to position the target at that place.

Mr. Fithian. Is target two--which doesn't really show up from here, but you pointed to it--is that at as nearly an accurate location as possible?

Dr. Barger. May I ask Mr. Cornwell a question?

Mr. Fithian. Yes.

Dr. Barger. I forget right now which Zapruder frame we tried to position target two at.

Mr. Cornwell. We initially attempted to place it in the vicinity of 190, which would have been slightly further down the street from where it ultimately ended up, but the tree size is different today than it was in 1963, and the signs over the street which are in that area were of course not there in 1963, so we had to simply find the shortest point from the 190 frame that we could still shoot at sandbags. It was moved, as I recall----

Dr. Barger. The reason we were striving for the location of the limousine in frame 190 were obscured by the new growth of the tree and so moved it to that position to make it----

Mr. Fithian. Doctor, the reason that I am going into this is that in studying the data last night form your reseach, and going over what you find as possible matches and then eliminating those which you believe to be false signals, there seemed a dirth of any matches with the second target in your data.

The question is whether or not there is anything--we have already eliminated the new hotel building several blocks away as having been in any way altering the echo pattern.

I am curious to know whether or not the location of that target, the interstate signs, the firing direction or anything like that would tend to give us the kind of data that we seem to have on target two.

Dr. Barger. Three of the matches were achieved for test patterns obtained by firing at target two. I wouldn't describe that as a dirth, that is to say, three out of 15 would represent.

Mr. Fithian. But if I may come back to this a little bit later, if you want to remember the point and we will take it up then, if I remember in going through the ones that you eliminate as false alarms, that reduces any match to target two either to one or two zero, I am not positive, but we will come back to that.

I just was curious to know whether the intrusion of the interstate signs into the whole acoustical pattern does anything to the results you get.

Dr. Barger. Yes. The target two was responsible for at least two false alarms. Let me just check this a moment and make sure. Yes, it contributed false alarms in each case. There was a detection made at the second time interval when a shot was fired at target two, and that one was eliminated because it was detected at microphone five in the third position, and that was the one that would have required a 100-mile-an-hour speed of the motorcycle to achieve, and so that was labeled as a false alarm.

Target two contributed a false alarm here, which was one of the three detections made of the third time segment. That too is ruled out because of improbable required motorcycle speed to achieve that position at microphone seven at the time of the third group of matches, and finally target locations, a shot at target location two, contributed a false alarm in the fourth pattern, that once having been identified as a false alarm by the improbably motion of the motorcycle required to achieve it, so that is correct.

The three detections that were achieved from test patterns obtained by the shooting at target two appear to be false alarms.

Mr. Fithian. What impact, if any, did the firing of the bullet from the school depository window between the two interstate signs, what impact would that have in altering the data, if any?

Dr. Barger. The presence of a structure such as this would have been highly irrelevant to the tests had it been over here.

Mr. Fithian. You say ''highly relevant''?

Dr. Barger. Irrelevant.

Mr. Fithian. Irrelevant.

Dr. Barger. Had it been over here. The fact that the trajectory of the bullet missed that sign by only a few feet indicates that, as the shock wave which is radiated from the bullet as it passes, would be in fact scattered by those signs, generating a new source of sound at that point.

Mr. Fithian. And so then you really couldn't expect to get a match-up; is that what you are saying?

Dr. Barger. That would introduce additional echoes in the test pattern that would not have----

Mr. Fithian. Let me make sure I am correct.

If you introduce additional echoes, or if you get additional echoes anywhere that don't match up, that reduces the probability, reduces it from eight to seven or seven to six or six to five or whatever.

Dr. Barger. It reduces the probability of detection and it increases the likelihood of a false alarm.

Mr. Fithian. Thank you.

Now I also looked at the pattern of shooting and noticed that you did not have as many shots from the grassy knoll toward No. 2 as at the other targets. I think No. 1 and No. 2, if I am not mistaken.

Were there any reasons why you didn't have a full round of firing?

Dr. Barger. Yes. I think you are referring to the fact that we did not fire at Target 1 from the knoll.

Mr. Fithian. I am sorry, I said 2. I meant 1.

Dr. Barger. Yes.

Mr. Fithian. Yes.

Dr. Barger. That is correct. When we were setting up the locations of the microphones and the rifles and so on, we observed that Target 1 was directly between the rifle on the knoll and the spectators that had been positioned behind a barricade on Elm Street, and it was judged entirely inappropriate to attempt that shot.

Mr. Fithian. Now there is one other question I need to ask about what is up on the board there on the easel.

When we visited Dallas, when the committee visited Dallas, and we inspected the Texas School Book Depository, we were told that, at the time that they picked up the shells, the empty cartridges on the sixth floor near the corner, I believe it would be about where the gentleman is standing or in that area, that the area was physically cased in by boxes, not quite entirely, but nearly so, and that some writers have described this as the sniper's nest, et cetera.

But in any event, to get to the acoustics of it, would those stack of boxes in the depository right around where allegedly the shots were fired have any significant impact on the echo pattern that you could expect to get outside?

Dr. Barger. They would not have a significant impact on the matches performed with the echo patterns, and the reason is they would introduce into the echo patterns additional signals which are reflected from the boxes you describe that occur at a time later than the muzzle blast. By the time it takes the sound to go from the muzzle to those boxes and back out the window, that amount of time would be less than 12 milliseconds, if those boxes were within 6 feet of the rifle. And we have, as I described, in describing the matching procedure, broadened the width in time of each impulse on the motorcycle tape by 12 milliseconds in order to accommodate the uncertainty of microphone position relative to motorcycle, which as I said was 9 feet. And the broadening of the acceptance time for each impulse in the motorcycle tape solves the uncertainty caused by the lack of precise microphone location, since we didn't know where the motorcycle was. It also solves the problem that you just described.

Mr. Fithian. Let me see if I understand that now.

What you are saying is because the little elliptical bends that you put over these blips--I don't use very scientific language here--but that you put over these blips in the spectrograph because they accommodated up to, what did you say, 6 feet on either side?

Dr. Barger. Yes, 12 in total.

Mr. Fithian. Twelve feet total, that the boxes in order to have been in any way effective would have had to have been closer? In other words, your accommodation, your allowance, took in any allowance for the boxes being there or not being there?

Dr. Barger. Yes, providing those boxes were within 6 feet of the muzzle. If they were significantly farther than that, then the echo coming from them and trying to get back out of the window and thereby becoming relevant to the test pattern would have been beaconed so that it wouldn't have had any significance either.

Mr. Fithian. For practical matters, you are saying it doesn't make any difference whether you stack up boxes when you are doing the test firing or not?

Dr. Barger. Absolutely.

Mr. Fithian. Thank you.

Let the record show that the question pertained to Exhibit F-342, the picture of the marksman.

Now one thing that has been bothering me this morning is the possibility that since more than one radio could be transmitting on that Channel 1 that the stuck microphone was on, that indeed we might have been picking up some sounds from somewhere out of Dealey Plaza or somewhere else by some microphone other than the stuck microphone, since I believe you said that the bell tone was off outside. The bell tone did not come in over this particular microphone----

Dr. Barger. That is right.

Mr. Fithian. ----to any way that we could locate. Then why couldn't we hypothesize that perhaps the third or the forth shot or the first or the second shot might indeed have been picked up, that kind of a sound might indeed have been picked up by some other radio trasnmitter trying to be keyed somewhere else other than Dealey Plaza?

Dr. Barger. Yes. We did establish, particularly with the spectrograms, that other microphones were keying in particularly at the times, the later two times, according to Time 3 in green and 4 in black on that exhibit. And so during the time when those other radios were transmitting sounds from their microphones would be expected to also appear in the tape recording, and, therefore, if a pattern of impulses was generated by some mechanism at the location of the other microphone, then that pattern too would appear on the recorded sound.

However, these patterns were quite complex. They contained no fewer than 10 echoes, as I recall, spread over total times no less than about half a minute--let me see now, half a second--and the interval of time between each of these 10 echoes over this whole period of time, half a second or more, is a very intricate pattern. The likelihood that some other mechanism that would generate a similar pattern that would match with the test patterns is extremely remote.

Mr. Fithian. And if one of the microphones were one of the other motorcycles in Dealey Plaza, what theen?

Dr. Barger. If another motorcycle in Dealey Plaza keyed in at that time, you would have a test pattern, if you will, that is to say, you would have the sound of gunfire on that one too. If it was sufficiently noise free that our detection process caught it, it would have shown a high value of correlation in the match and would have been marked as a detection.

Mr. Fithian. But it would have come at the same time frame though if it were a shot in Dealey Plaza; is that correct?

Dr. Barger. That is correct.

Mr. Fithian. And so the only thing that would be somehow altered would be the location of the motorcycle.

Dr. Barger. That is correct.

Mr. Fithian. So what you are saying is that the only way you could have gotten the pattern to match is if over some other transmitter that was not in Dealey Plaza, to get those 10 or 15 or however many echo patterns matched up, there would have to be a configuration somewhere else very much like Dealey Plaza. The transmitter would have had to have been keyed at exactly the right time, and then you would have had this----

Dr. Barger. That is correct.

Mr. Fithian. How would you classify that; very unlikely, impossible, remote?

Dr. Barger. Extremely unlikely.

Mr. Fithian. When you set you to go to Dealey Plaza, you expected a certain approximation or a certain number of impulses. In general now, not referring to any specific, but your general conclusion, did you get the approximate number of impulses that you anticipated?

Dr. Barger. Yes.

Mr. Fithian. I want to ask this question again, and that deals with the term you used, ''correlation coefficient,'' where you got those.

Would the correlation coefficient be altered if the motorcycle is not at the exact location of the test microphone? In other words, you talked about a correlation coefficient of 0.8 or 0.7, 0.75, 0.6.

Would that have been altered if the location of the microphone were 8 or 9 feet away from where the motorcycle actually was when the Dallas PD tape was made?

Dr. Barger. I am glad you asked that because I don't think I made this point very clear the last time. The purpose for accepting as a match an impulse that occurred within plus or minus 6 milliseconds of an echo was to try to overcome the problem of a low correlation occurring if you by chance did not have the microphone in exactly the right place. If you insisted that those impulses line up with those echoes precisely, you would have to have the motorcycle just where the microphone was. We didn't have that many microphones or that much time, and so we used, as I said, the 18-foot spacing of microphones.

In order to prevent a loss, a significant loss of correlation, because of the uncertainty with respect to the location of the motocycle and the microphone, we accepted anything that came within 6 milliseconds as a match.

Now let me explaiun where 6 milliseconds came from. I was trying to guard against low values of correlation, and therefore loss of information, just because I happened to miss the location of the motorcycle, but I couldn't accept as a match echoes and impulses that were half a second apart because then I would accept everything, so it is necessary to find a medium ground.

Now here is how that was done. In the case where the microphone and the reflector that is causing the echo and the source are all in one line, then the 9-foot uncertainty that I had with the 18-foot spacing, plus or minus 9 feet, would generate a plus or minus 9-millisecond uncertainty in the location of the echo.

Now it is also true that if the sound that generates the echo that I am interested in is arriving perpendicularly to the line connecting the microphone and the possible place of the motorcycle, then that uncertainty is of no consequence because it would arrive at both of the two places at the same time. So the error caused by this phenomenon is very similar between zero and 9 millionseconds. So mathematically we said the arrival of these echo sounds from each direction is equally likely, and we determined an average of the error that would be introduced by a 9-foot uncertainty, and it was 6 milliseconds.

This is not a linear average. That would have given 4-1/2, but there is a cosine involved in this, and so the 6-millisecond uncertainty was arrived at in that way, and it was designed to minimize the loss of correlation due to uncertainty in the microphone location.

However, it won't work perfectly because in those cases where the error is actually 9 milliseconds, when the error happens to be coming in in the same direction as the line connecting the motorcycle and microphone, then it will cause a lack, a loss of correlation.

So the answer to your question is there is a slight loss in correlation but it is not as large as it would have been if we had not used the plus or minus 6-millisecond window.

Mr. Fithian. Staying with the loss of correlation, because some of us are bothered when you match up a shot pattern that we know happened, and you can't match up all the 12 blips or the 15 blips or whatever, here and there, what you have just said is that some of them might be attributable to the fact that the motorcycle was outside by 3 feet or whatever. In other words, you might get a reduction in the correlation coefficient because the motorcycle is just beyond your tolerance level.

Second----

Dr. Barger. That is right.

Mr. Fithian. Would you get a reduction in the correlation coefficient if induced into the tape by a second transmitter somewhere there were noises that exceeded the threshold level that you established?

Dr. Barger. Absolutely. The presence of impulses in the motorcycle tape that we counted, because we observed them to be there, that are caused by nonacoustical effects, give us therefore the impossibility of achieving a match because they were caused by some entirely different phenomenon. And the way of computing the cross correlation coefficient or the correlation coefficient that accommodates that, in other words, in the denominator is the square root of the number of impulses. If there is a lot of noise in the tape, as there is a good dea, and many of those impulses are caused by that, they can't be matched, and they will reduce the level of the correlation coefficient just mechanically, because there are numbers in the denominator. So if there are lots of noise pulses, that will reduce the correlation coefficient, exactly.

Mr. Fithian. So you would not expect to get a one, or I think you used the term ''unanimity.''

Dr. Barger. The motorcycle tape is so noisy, not only with the sound of the motorcycle, but also keying transients and the like from other transmitters that it would be extremely unlikely that you would have a segment of the tape so noise free that a perfect correlation would be achieved, and in fact none were.

Mr. Fithian. From what you know about the echo pattern of the Mannlicher Carcano rifle, what insight, if any, can you offer into Governor Connaly's testimony, if you heard it or read it?

Let me try to reconstruct.

Do we have the transcript of Governor Connally?

On September 6, Governor Connally testified and said that--let me back up here a little ways. Let me take his last part of his testimonmy first.

He says, ''I heard another shot. I heard it hit. It hit with a very pronounced impact,'' and at that point the governor slapped his hands together to demonstrate the sound that he heard. ''Almost like that.'' He said ''It made a very, very strong sound.''

Then he says ''Immediately I could see blood and brain tissue all over the interior of the car and all over our clothes. We were both covered with brain tissue,'' and he goes on.

Now, as I interpret what the governor said, after he had been hit, and Mrs. Connally had pulled him down into her lap, he was still conscious, and he heard what sounded like a shot, and then heard what sounded like the bullet striking the President's head.

Now, No. 1, if in fact the speed of the bullet is supersonic, you could not hear it in that sequence; am I correct?

Dr. Barger. That is correct.

Mr. Fithian. In other words, he would have had to have heard the bullet striking the skull first, and then the muzzle blast would come at some fraction of time after that?

Dr. Barger. That is correct.

Mr. Fithian. Well, then, obviously there has to be some other interpretation of those sounds, if in fact the governor heard the sounds correctly.

Can you shed any light on this at all?

Dr. Barger. Yes. The findings, as I have described them, are that if there are four shots, they have the sequences that we described, and in fact, if you could uncover that back chart, please, you will see that the time segment marked in green occurs a half a second before the time segment marked in black. Therefore, if there are four shots, the times that they occur are shown there on that chart, the last two being a half a second apart.

RPTR COCHRAN

2:45 p.m.

Now, as I indicated, there are false alarms in this detection experiment or test that I have conducted, and so, therefore, it is the purpose of other evidence to compare to these findings to see which--if you can determine which of these findings are, in fact, corroborated or are discredited by other evidence, and, in that sense, the comment that former Governor Connally made is of some relevance because a statement that two loud sounds were heard, separated only by a small period of time--I don't remember exactly what word he used--''shortly thereafter,'' as I recall--would indicate that he heard two loud impulsive sounds at the time of the third shot. I can't put any significance in the fact that he may have inverted the two times. That was a traumatic period, obviously, for him. But it is interesting that he did, in fact, characterize the sound of impact as what must have been the sound of a rifle, because it would seem possible, then, that that is possible testimony to indicate there were two briefly separated impulsive sounds that might have been shots.

Mr. Fithian. I agree with you obviously it was a very traumatic and almost impossible-to-imagine state of mind. I recall the Governor saying very clearly, early on, that he had done enough hunting that he recognized rifle shots when he heard them, et cetera, and that is what caused him to turn his head at the beginning way back, 170 or 180, whatever, and he did characterize--if there are only three shots and the last one is the one that hit the President in the head, then he had to confuse what would have been a bullet wound in the skull with a rifle shot.

Dr. Barger. That is correct.

Mr. Fithian. As an expert in acoustics, can you just help me out in trying to distinguish what the differences in characteristics would have been?

Going back to my original premise of the question, the first thing he heard after being in Mrs. Connally's lap could not have been a rifle shot if there is only one shot fired.

Dr. Barger. That is right.

Mr. Fithian. The first sounded to him--if you ''X''out our fourth one or third one you have come out with as a possibility, prior to the head shot, then that first noise the Governor heard could not have been a rifle shot.

Dr. Barger. If he could have heard the sound of the impact at all, as he thought he did, then it could not have been the second sound that he heard; it would have had to have been the first--what he described as an impact.

Mr. Fithian. I was hoping you could describe what the human ear would hear from a bullet fired from the depository and an impact six feet away, or whatever.

Dr. Barger. I have no concept of the impact sound. I really have no opinion on that.

Mr. Fithian. I want to return to that troublesome shot from the grassy knoll, the third one that comes just ahead of the obvious head shot. If we are to stay with three bullets being fired as our final interpretation, then we have to somehow or other rationalize a way or do away with or accept as other phenomena the third impulse that you have on your charts, is that correct?

Dr. Barger. That is correct.

Mr. Fithian. What might the third impulse be, then, if it isn't a shot?

Dr. Barger. If it is a false alarm, which I described as the alternative to being a correct detection, by the very nature of a false alarm, it cannot be very easily explained. The only reliable procedure I can conceive of for identifying it as a false alarm is by comparing the time that it had to have occurred with all other testimony that has come and will follow about the possibility of that having occurred.

Mr. Fithian. Random statistical errors? Would that have done it?

Dr. Barger. As I indicated just before, I think there is an even chance about half of those remaining detections are, in fact, false alarms. Each one has an even probability of being one, including the one you just cited. I guess there is a chance of random error that that correlation occurred.

Mr. Fithian. I would like to recall, Mr. Chairman, JFK Exhibit 370. Doctor, if you would proceed over there, I want to make sure before I turn you loose here that I understand that vital chart.

Now, starting from the lower left-hand corner, where originally on the chart you had four possible verifications, and you eliminated one, you are fairly certain that that is the first shot, and you are fairly certain of the location of the motorcycle within 10 feet; is that correct?

Dr. Barger. The origin of this chart represents the estimate that the motorcycle was half-way between microphones 5 and 6 at that time; that is correct.

Mr. Fithian. Now, you use the term ''false alarm.'' Perhaps we should put up F-367 there for you to refer to. I notice in some of those that you rule out as false alarms they are really the same shot except that one is with the muzzle at the plane of the window and the other is with the muzzle two feet inside. Isn't that correct?

Dr. Barger. There were these two which you must be referring to.

Mr. Fithian. Take number one, for example.

Dr. Barger. This one?

Mr. Fithian. Yes. Which one have you eliminated--one of them you have eliminated, but is it meant that the first shot heard would have been from the grassy knoll and it would have been aimed at the target clear down by the underpass; is that correct?

Dr. Barger. That is correct.

Mr. Fithian. So you elimiunated that just because it wasn't very probable that the first shot would have been 75 degrees away from where the limousine was, or whatever?

Dr. Barger. That is correct. I used that as an example of the lack of any evidence to corroborate someone doing that.

Mr. Fithian. That leaves three matches or verifications you came up with right in that timeframe?

Dr. Barger. Yes.

Mr. Fithian. As I read this chart, two of those are shots which were fired with everything exactly the same except that the rifle muzzle was withdrawn two feet from the plane of the window.

Dr. Barger. That is correct.

Mr. Fithian. And so, in fact, all three of those matches come from the microphone being in the same place and everything else being in the same place with the exception that you fired one, which is shot number 3, which has a .8 correlation, co-efficient, with the muzzle at the window plane, and you fired the other two, having .8 and .7 correlation co-efficients, with the muzzle of the Mannlicher Carcano withdrawn inside the window two feet. That is the only difference, isn't it?

Dr. Barger. That is correct----

Mr. Fithian. I am trying to account for all these extra dots, because to the average person looking at that, it looks like there are 15 different shots and obviously that is not the case. We are trying to match up signals from repeated tests, and your verifications come up with four of those being possibly correct, and you eliminate one as being highly improbable.

Dr. Barger. Yes.

Mr. Fithian. But the other three are all from a Mannlicher Carcano shot from the window into the target.

Dr. Barger. Yes.

Mr. Fithian. As you move on over about one and a half seconds we see another group of shots which you have marked with a red circle.

Dr. Barger. That is correct. These are marked here and listed in this table.

Mr. Fithian. As I take it, there are possibly four matches in that area. You have ruled out the one from the knoll at the target number 2. The remaining four, again, are fired from the same place, the only difference being that it is with the muzzle withdrawn and two of them with the muzzle at the plane of the window.

Dr. Barger. That is correct.

Mr. Fithian. So, again, then we are not really talking about a different variety of shot impulses on the original tape. These are shot impulses you put on the test tape because you fired several times, isn't that correct?

Dr. Barger. That is correct.

Mr. Fithian. And the reason they show up at that timeframe match would be because on the original tape that is when the second shot was fired. Is that correct?

Dr. Barger. That is very close to correct. Two indicate that is where on the original tape is the pattern of impulses that looks like the test shots.

Mr. Fithian. Now you are aware that the FBI test firing by the expert indicated you couldn't fire the Mannlicher Carcano more rapidly than 2.25 or 2.30 seconds. That much time had to separate shots. You are aware of that testimony in the Warren Commission.

Dr. Barger. If it turns out--I am aware of that and was.

However, that information was--I had no reason to put high reliability on that, and I could not allow that to consider the interpretation of the results.

Mr. Fithian. You are saying--with your careful scientific analysis of this tape--saying the first two shots are 1.6 seconds apart; is that correct?

Dr. Barger. Yes. I felt confident in ruling this one out, because I was certain there was no motorcycle going 100 miles an hour. On the other hand, the fact that all of these things came up 1.6 seconds later is the way the test developed, and that is the result that was obtained.

Mr. Fithian. I want to make sure I also understand, when you look down in that lower left-hand corner, near the red circle, you have two dots below and two dots roughly above the imagined track of the motorcycle, but, again, during the same timeframe--from here it looks like that might not be the case--you have the upper right-hand matchup in that group of four; is that correct?

Dr. Barger. Would you repeat that again?

Mr. Fithian. In the vicinity of the red circle for shot number 2----

Dr. Barger. Yes.

Mr. Fithian. ----two shots just below represent the same timeframe.

Dr. Barger. Exactly.

Mr. Fithian. You had to space it that way.

Dr. Barger. That was artistic license; that is right.

Mr. Fithian. Now, if my eyes do not deceive me, the one immediately above that red circle is also in exactly the same timeframe, that 1.6.

Dr. Barger. That is correct.

Mr. Fithian. The fourth shot up and to the right, does that not represent a different timeframe?

Dr. Barger. This is the fourth detection, not the fourth shot.

Mr. Fithian. I am sorry. The fourth detection.

Dr. Barger. Of the four we have discussed so far.

Yes. That one is this one. In other words, four of the matches in this segment of the tape which I have listed here as occuring at this time, one, two, three, four, those all match at exactly the same place in the tape.

Mr. Fithian. And you eliminated the one clear up at the top next to the limousine, because that would make the motorcycle going 100 miles an hour?

Dr. Barger. Yes. For a reason wholly unrelated to the evaluation of the test.

I don't know whether there is another question remaining.

Mr. Fithian. I am wondering if any of the rest of those four down there are clearly false alarms.

Dr. Barger. I don't have any good indication that any of them are.

Mr. Fithian. If I am not mistaken, the upper right-hand one of those four is beyond the two-second time limit on your linear scale at the bottom; is that correct?

Dr. Barger. That is correct. This particular match occurred at a different time than the other four. This one occurred at a slightly later time. It achieved a rather high value above the threshold of the cross-correlation coefficient, but it did it in a way that was unlike any of the other four.

The early echoes in that particular pattern didn't match with anything. It was all the later ones that matched. Therefore, the first match that was actually achieved in the echo pattern did not correspond with the leading edge of the echo pattern. In a sense, it is conceivable the leading edge of the echo pattern could have been obliterated at that time by transmission from another motorcycle, or whatever. That would explain why its leading edge was off and its timing was bad. I included it in the results of the tests because objectively it had, in fact, exceeded the threshold of .6.

Mr. Fithian. Now, move to the third, which would be your green shot, or green matchup. That is the one that is 5.9 seconds later, or whatever the term is.

Now, am I not correct in visualizing that all three of those matchups are exactly on the same timeframe?

Dr. Barger. That is correct. All three of those occur at the same time, 145.15 seconds after the microphone button is stuck.

Mr. Fithian. So am I correct in assuming that if we are to discard that shot altogether or that echo pattern altogether, we have to discard all three of those despite the fact that you have three matchups on exactly the same timeframe?

Dr. Barger. I am not sure I understood that.

Mr. Fithian. Vertically.

Dr. Barger. These three?

Mr. Fithian. Yes. Those matchups occur from some kind of an impulse that goes at exactly that time; is that correct?

Dr. Barger. That is correct.

Mr. Fithian. So if we are to return to the three-shot theory, which has been existing for 15 years, we must reject all three of those as being false alarms of some sort; is that correct?

Dr. Barger. No, that is not correct. Or if it is true, I don't know why.

Mr. Fithian. If there are only three shot impulses on that tape you got from the Dallas police force, and we all agree one of them is down in that blue circle and that caused all those matchups as number 1, and we agree there are three matchups that are very close to the red circle for number 2, that accounts for two shots.

Dr. Barger. Yes.

Mr. Fithian. Then if we are going to accept the final series as the head shot--that is the one you have in black clear up to linear scale--if we are to reject an intervening shot, whatever is the number, we have to say that all of the match-ups on that time line are false alarms.

Dr. Barger. Yes, that is correct. If that were to be rejected for any reason, then all of those at that time would have been false alarms, that is correct.

Mr. Fithian. You said you didn't prove we had four shots and I was trying to eliminate one. There are four time line groupings that indicate four shots, so we have to do something to get away from one of those impulses which is shown on the vertical. Am I on the right line?

Dr. Barger. If there were in fact three, it would be necessary to identify both of those, or this one, or four of these, or four of those as false alarms. That is a further possibility. We have no evidence of more than four, but we have found there may be four and if there are they occurred with this time sequence.

Mr. Fithian. Congressman Edgar calls my attention to the fact that in the third sequence, the one we just referred to now, the green sequence, that one of those is from a shot fired at target two.

Dr. Barger. Yes, that is correct.

Mr. Fithian. If we match up the Zapruder film, it seems unlikely.

Dr. Barger. The target location is one target location removed, but that is not a very large difference.

Mr. Fithian. I think that is all the questions I have on that particular chart.

Would you and your team reconstruct for the committee the sound of the gunshots as they would have been heard if in fact we are to accept this final chart with four impulses? Do we have a sound recreation of that?

Dr. Barger. Mr. Robinson has prepared a tape splice-up of the four test shots that were representative of the four possible locations where there might have been shots and I believe he is prepared to play that.

Mr. Fithian. If the Chair would permit, I would like to have it played.

The Chairman. You may proceed.

Mr. Cornwell. Mr. Chairman, we might identify it for the record as a tape recording, Exhibit F-353 and we would like to have it admitted into evidence.

The Chairman. It will be so identified and so ordered into the record.

[The information follows:]

********** INSERT **********

Dr. Barger. I think it would be appropriate for me to tell you where those sounds are recorded.

That was Microphone 5. If we can see the exhibit that has the map of Dealey Plaza----

Mr. Fithian. I believe it is Exhibit F-337. I have one last question on that anyway.

Dr. Barger. What you just heard were the sounds picked up at this microphone of shots fired from here, the first two; one shot then fired from here, followed half a second later by one shot from there.

Mr. Fithian. Could you point to the place on the street where the motorcycle would have been located when the third of those impulses or shots were recorded?

Dr. Barger. Yes. The estimate of the motorcycle position that we achieved by this test placed it 120 feet behind the presidential limousine. Given that the presidential limousine was just short of 313 at the time of the fourth shot, the position of the motorcycle was then 120 feet behind it at this position.

In fact that green dot represented the estimated position of the motorcycle at the time of that third impulse we detected that might be the knoll shot, in fact. The black dot here represents the position of the motorcycle where it would have been at time the of the fourth impulse we identified as a possible shot.

Mr. Fithian. Thank you. I have one last question having to do with the authenticity of the tape itself that you worked with. I am sure that many will want to know whether or not there is internal evidence or otherwise that can attest to the fact that the tape which you were working with--that is, the original tape you were working with--was indeed a tape of the shootings in Dealey Plaza on November 2, 1963. What information can you shed as to your best judgment as to which tape you were working with?

Dr. Barger. In the first place, the tapes received from the colmmittee staff were represented as being that. However, at a different time we received a Dicta-belt, which is a plastic continuous belt that was marked ''Being recorded from Channel 1'' in a white marking pencil.

Channel 1 of the Dallas police tape on November 22, 1973. We obtained a rebuilt Dicta-belt recorder, newly rebuilt, and we played that particular belt and made our own magnetic recording of the Dicta-belt. We then analyzed this middle segment around 12:30 of that recording that we had made from the Dicta-belt that we received and also on the same computer and in the same way we had the first one and had it print out a record, a wave form record. We compared the two and found it to be the same in virtually every detail.

Mr. Fithian. The appearance of the Dicta-belt, was there anything there that would indicate anything to you?

Dr. Barger. It had the appearance of being quite old. The margins of the belt were cracked and it was necessary to tape them together to prevent further deterioration.

Mr. Fithian. Are you satisfied from a scientific analysis and in fact the way you have described it carefully this morning, that this particular recording passed all of your six screening tests; that you were indeed working a recording of Dealey Plaza, November, 11, 1963?

Dr. Barger. Yes. The likelihood that the shape of the patterns that we achieved correlations on have come from some other place, it seems extremely remote to us.

Mr. Fithian. I would ask staff counsel Cornwell whether or not we have additional information on the chain of custody.

Mr. Cornwell. We do have additional information, Congressman. We had obtained the tape rcording and Dictabelt originally from Mr. Paul McCarran, who is now a retired member of the Dallas Police Department. We know the details of the story that we received at the time we got the tape from Mr. McCarren. He is here today. I can either summarize for you the information he has provided, or he is available if the committee so desires, and could testify as to those facts himself, at your convenience.

Mr. Fithian. Mr. Chairman, I would not want to interrupt the committee's questioning of the witness now on the stand, but I would ask that immediately upon conclusion of this we bring the witness forward who can attest and I think probably very briefly, but certainly as to the chain of custody. I think it is very important that we do this.

The Chairman. The Chair will be glad to entertain that.

Mr. Fithian. Mr. Barger, I certainly want to thank you for your answers and your insight and I would appreciate your final collective judgment as to whether there are three or four impulses on that tape that could represent gunshots?

Dr. Barger. We have endeavored, Mr. Fithian, to make as powerful a direction test as we could devise and to lower the acceptance threshold of those matches that passed the threshold so that all likely corrected detections would emerge. In so doing, we found the process has sufficient noice in it that some of the detections that passed our threshold are false alarms.

We believe that the chances are very high that we have in fact located the motorcycle and, of course, that was done by matching sounds of gunfire. Therefore, to believe the conclusion that there were at least two shots is very high because it would take at least two to establish that pattern on the chart. You can't draw a straight line through one point.

The indication is that there are probably somewhere between three, maybe six additional false alarms in there that we cannot on our own information correctly identify as false alarms. Therefore, we think each of the detections that we have made is about equally likely to be a false alarm.

It would be possible, as there is only one detection remaining for the third shot--I don't remember what color it was, but it was the knoll shot. Only one detection. It is about equally likely that is a false alarm. Therefore, it is about equally likely that there were three shots. There is an equal likelihood that there were four and if there were, we have determined the time at which they occurred and, we also believe, the location to which they have come.

Mr. Fithian. If there were four locations, it would have been what?

Dr. Barger. There would have been those indicated in the chart that was up there a little while ago.

In the first place, all of the detections that were not clearly false alarms were fired from the Book Depository. At the same time, 1.6 seconds later, likewise those that have not been identified as clearly false alarms are from the depository.

In a third case, the one that is not disqualified by inappropriate time motion of the motorcycle is from the knoll and the last one, half a second later, those two non-discovered points are both from the Book Depository.

Mr. Fithian. Thank you. Thank you, Mr. Chairman.

The Chairman. The time of the gentleman has expired.

The committee will now proceed on the five-minute rule.

Doctor, I am going to ask that you replay the tape that you played a few moments ago. Prior to playing the tape, I am going to ask you to tell us what we ought to listen for and ask you further to tell us precisely what we should conclude from what we have heard.

Dr. Barger. I won't presume, Chairman Stokes, to tell you what you should conclude from anything.

The Chairman. What do you conclude from what you hear as an acoustical expert and as a scientist?

Dr. Barger. You are asking me my opinion of the sound of those shots now before they are played a second time?

The Chairman. Yes.

Dr. Barger. I just heard them for the first time in that order. Of course, I heard them singly several Sundays ago in Dallas.

I really think my opinion about them is of no particular value. Professor Green, who will follow me, is an expert on how sound should affect people.

I am more expert in how it affects microphones. As I say, when I first heard them it sounded like a shot that I saw several Sundays ago. Why don't we hear them again?

The Chairman. May we have the tape played again, please?

(Tape replayed.)

Dr. Barger. Let me add all of the hissing noise you hear is necessary to make the impulsive sounds sufficiently audible because they are so brief that they have to be loud in order to be clearly heard.

The Chairman. Now, you are in a better position to respond to my original question.

Dr. Barger. I understand the question is, what do I think those sound like, is that correct?

The Chairman. When I listen to that tape can I come to a conclusion from what I appear to be hearing?

Dr. Barger. I think not. The microphone is a device that accepts sounds from all directions with equal facility, whereas the human is not. The human can make a judgment about the directions from which the sounds arrive and this was not an exterior recording so we haven't been able to replicate the directionality of the sounds and various echoes and therefore I just don't believe I can reach a meaningful conclusion about how those sounds should be interpreted.

The Chairman. I am rather concerned about the nine-foot uncertainty which you ascribe to the location of the motorcycle. I believe that is your testimony, is that right?

Dr. Barger. That is correct.

The Chairman. In order to reduce or lessen the uncertainty with reference to the placement of the motorcycles, can you tell me to what degree you have studied the Zapruder film or any other films or to what degree you have studied photographs in order to try and reduce the uncertainty?

Dr. Barger. I think the only way photographs would be helpful would be to show where the motorcycle in fact was. I know of no such photographs at the time of the shooting.

The Chairman. What I have in mind, Doctor, is with reference to the placement of the motorcycle because there is where the uncertainty comes. That is precisely where the motorcycle was in Dealey Plaza at the time each of the shots were fired, is that correct, and that is where the uncertainty comes in?

Dr. Barger. That is where some of the uncertainty comes from.

The Chairman. You make an allowance in terms of the uncertainty, is that right?

Dr. Barger. We made an allowance in the correlation procedure to accept some uncertainty in the microphone location.

The Chairman. All I am attempting to ascertain from you is something to reduce or lessen that uncertainty as much as is scientifically possible.

To what degree did you study any available photographs or films in order to try and make a more accurate placement of the motorcycle?

Dr. Barger. Well, before we conducted the detection experiment, we had absolutely no idea which motorcycle it was. We could look at motorcycles a lot and it wouldn't tell us anything.

After we did the detection experiment and then had half of the motorcycle revealed to us, we found, in fact, that it appeared to be about 125 feet behind the limousine. If we look at the photographs available to us, we will see if there were any photographs taken at the time of the shooting of that part of the motorcade about 120 feet back, and we found none. We have seen some photographs taken less than one minute before the shooting, and there are motorcycles back there, but there is so much time elapsed between those pictures and the time of the shooting, it wouldn't help us.

The Chairman. My time has expired. The Chair recognizes the gentleman from Ohio, Mr. Devine.

Mr. Devine. Thank you, Mr. Chairman, and thank you, Doctor. I think you are a very patient man to go through this in methodical detail.

I have a couple questions as a non-science layman. I would like to know what is your definition of a false alarm.

Dr. Barger. A false alarm is the correct description in detection theory for an indication from your test that an event occurred when in fact it did not occur. Our test, which was a correlation detector, was set up to give an indication that an event occurred whenever the correlation co-efficient exceeded 0.6. Every time that happens, there are two possible outcomes. One is, we have got the indication of the detection of the gunfire event when, in fact, there was a gunfire event at that time--let's call it detection. The other possible outcome is there was not, in fact, a gunfire event at that time. That is called a false alarm. In other words, it is an error, a mistake.

Mr. Devine. Well, it either happened or it didn't happen, I suspect, when we are talking about either sound waves or whatever detection you are talking about. I was under the impression it might be a convenient way to eliminate the unexplainable.

Dr. Barger. Unfortunately, there is no way to eliminate the unexplainable. False alarms don't have to be hard to find. Some of our identifications are easy, in that they would allow the motorcycle to fly all over the place. On the other hand, a false alarm can mimic the correct detection, and if it mimics it well, it is hard to identify as a false alarm, and, in fact, I present the results of our test in this way, with the hope that it will be the easiest job possible, in the face of uncertainty, for the committee to consider their testimony as potentially requiring verification or refutation and would be helpful to know when, if they occurred.

Mr. Devine. I believe you said in your summary by your tests you have located at least two shots that were fired that were not false, and that there was an equal likelihood that there was a third or fourth shot. I mean it is likely that there was or wasn't a third and fourth shot. It seems to me as one who was in the past a fire-arms expert, having spent a lot of time on the range and recognizing rifle fire, my personal interpretation would be that the first, the second and fourth noises sounded to me quite a bit like a rifle shot, the third noise that immediately preceded sounding like possibly something else. I am not that sure, and I haven't had enough time to listen and study, but it brings me back to what you said earlier--I think it was brought out in Mr. Fithian's questioning that Secretary Connally couldn't possibly have heard the shot that hit JFK's head before the sound of impact when the bullet hit the head. To the contrary, he may have heard the head explosion before he heard the shot that did it. I think of his immediate proximity to the President, the muzzle philosophy, and so forth. Isn't it possible that he could have heard that explosion prior to the shot that caused it?

Dr. Barger. He would have had to hear it first.

Mr. Devine. I don't know if you were here when he testified. He brought out what he thought was a head hit.

Dr. Barger. Yes.

The Chairman. The time of the gentleman has expired. The gentleman from North Carolina, Mr. Preyer.

Mr. Preyer. Thank you, Mr. Chairman.

Following up the comment of Mr. Devine about the sound of the shot hitting the President's head, that Mr. Fithian asked you about, one thing I would like to get the record clear on: I think you stated you had no opinion as to how a bullet would sound hitting the President's head, but can you say one way or the other that it would not be nearly as loud a sound as the sound of a rifle shot firing?

Dr. Barger. I have here the sound of rifle shots. I haven't heard anything approximating that other event, and, therefore, what I am giving you is not an opinion or scientific evidence; it is an off-the-wall guess.

I would imagine that the sound of an impact of that sort would not be as loud as a rifle shot.

Mr. Preyer. What I am getting at is, in the last two patterns on the paper, the possible third and fourth shots could not possibly be (1) the rifle firing, and (2) the head exploding.

Dr. Barger. Those events did not occur in that order; that is correct.

Mr. Preyer. Is there anything on the tape that could possibly give you an indication of the headshot sound?

Dr. Barger. You could not interpret those sounds in that way; that is correct.

Mr. Preyer. We might have some confusion on that.

You mentioned at the end of your statement to Mr. Devine that the committee should view this as evidence, as I understood you to say, which potentially requires verification. Something to that effect.

Earlier my notes indicated you said something like this, ''Since there are false alarms, we must examine the other evidence to see whether this corroborates it or not.''

My question is, did you regard the evidence of your experiments here as what we would call in the law corroborated evidence only or would you consider it correct primary evidence?

In other words, you seem to be saying this is not like an X-ray, exactly, and in no way is it a physical reality and a fact, that this is subject to error, subject to false alarms and it should be used to corroborate other evidence which should not be used in itself to prove the truth of the statement it makes.

Dr. Barger. I am not certain of the question, but I think you are observing that I said that the potential of the evidence we are presenting is a potential corroborating force for evidence.

Mr. Preyer. How far has acoustic science developed? Is it in a state still partly art and part science?

Dr. Barger. The results of the tests that I made I have presented as objectively as I can.

I am required to point up the uncertainty in the results.

I am not sure I am answering your question. Would you try to help me by reminding me?

Mr. Preyer. I think you have been very conscientiously objective and understate rathr than overstate.

Do you say there is about a fifty-fifty chance there wa a third and fourth shot?

Dr. Barger. It comes down to that because the third shot indicated in green is supported by only one detection and since I don't feel I can put more confidence in any single detection than I have indicated, the possibility of the third occurrence actually being a shot is about even and since, if that is presented, it is not a question of four or three. It comes down to what you said.

The Chairman. The time of the gentleman has expired. The gentleman from Connecticut, Mr. Dodd.

Mr. Dodd. I think you may have just answered my question, Doctor, in your answer to Judge Preyer's last question to you but, for the purpose of clarity, again you have obviously made a judgment here with regard to the possibilities of certain indications on a spectograph being what appear to be gunshots.

Could you state for us what the probabilities are for the first, second, third and fourth sounds being gunshots?

Dr. Barger. Yes, I will attempt that. Altogether I said the pattern of the detections that we achieved were tested statistically and found to be such that they would have arisen by chance only fifty percent of the time.

So I think therefore the probability that we have found at least two is very high.

Mr. Dodd. What would you mean by very high? What are you talking about?

Dr. Barger. I think I just said I meant 95 percent.

The necessity that others be accepted----

Mr. Dodd. Would you try to speak to the microphone, Doctor?

Dr. Barger. The requirement that a third one be accepted would be dependent on either of two of the detections standing up in the fourth area or three standing up in the first area, for example. Those are reasonably likely in the case of the fourth, less so because it is only two. I guess an estimate on my part to state the possibilities, which you have asked about--and this is hard to do because I don't want to confuse the results of the tests as they stand. The probability that there are two that we have detected is 95 percent. The probability there are three we have detected is probably incorrect or is something between 60 or 70 percent; the probability that there are four is lower than that and around 50 percent.

Mr. Dodd. Thank you.

Would you indicate for me what effect the location of the targets have on the wave forms produced by rifles? Looking at F-367, there are target locations which seem to change and I was trying to follow you as you were trying to identify false alarms and what you think may not be false alarms and correlating those to target locations. Is there a significant difference and, if so, in the third area--I guess that is green over there--could you indicate to me what the target location differences would mean there?

Dr. Barger. I am not sure I understand that question.

Mr. Dodd. Let me first of all ask you, does it make a difference?

Dr. Barger. What target gives the correlation?

Mr. Dodd. Target location.

Dr. Barger. Yes.

Mr. Dodd. How about the wave form produced by rifle fire?

Dr. Barger. Yes. The exact location of the target has a different effect on the echo pattern depending on the location of the rifle, the target and the microphone.

If the rifle is pointing approximately ninety degrees or so away from the direction between the rifle and the microphone, then the location of the target has very little effect because the shock wave radiated by the bullet which is dependent on which way the gun is firing, never reaches the microphone anyway.

However, if the target is in such a location that the shot passes near to the microphone on its way to the target, then a change in the target location is important because in that case the sound of the shot is in fact a part of the pattern.

Mr. Dodd. Looking at the 145.15 second block -- that is the green block----

Dr. Barger. That is correct. That is green.

Mr. Dodd. We have got two separate target locations there. Do you have that before you? Can you see that?

The first one is the knoll; the second one is the School Book Depository, and the target location is 2. A third is Texas School Book Depository and that is in the first three, is that correct?

Dr. BArger. That is correct.

Mr. Dodd. Now, which of those did you exclude as a false alarm?

Dr. Barger. The last two were excluded as a false alarm because they were detections made in microphones 7 and 8, which are about 60 feet away from the location of the other shot which was at microphone 4, and it would have been necessary for the motorcycle to have been speeding up in order to achieve that position in the time allowed and the sound of the motorcycle was in fact diminished all throughout that time.

Mr. Dodd. I am sorry to ask you to repeat. If you accept the existence of a fourth shot occurring there in the black figures, that third shot you would have to accept as the rightful location being on the grassy knoll?

Dr. Barger. Well, under the presumption that you couldn't fire from the same place within a half second, that would be true. I think that is what you mean.

Mr. Dodd. Thank you very much.

The Chairman. The time of the gentleman has expired.

The gentleman from Connecticut, Mr. McKinney.

Mr. McKinney. As I listen to your re-enactment of the tape, there is a distinct difference between the third shot fired--not just a time difference, but a sound difference--between the third shot fired and the first, second and fourth.

Is my impression correct?

Dr. Barger. It does sound different to me, yes.

Mr. McKinney. It does sound differently to you?

Dr. Barger. Yes.

Mr. McKinney. Since that shot sounds differently and also is much closer to any other shot in time--at least from the re-enactment--how can you be sure that particular shot is not a false alarm?

In other words, you have two shots, at least to my ear--and I know my ear is not very accurate--that sounded alike in the beginning and then you have a third shot followed almost immediately by another one in the re-enactment. The third shot sounds quite differently. What is it about that particular shot that told you that it wasn't a false alarm?

Dr. Barger. Nothing told me it is not a false alarm. The features of that shot that caused it to have been detected in the first place was simply the pattern generated by it at that microphone matched sufficiently well with the noise on the tape at that time that it as accepted as a possible detection. I don't know whether it is a false alarm or not.

RPTR MILLS

[3:50 p.m.]

Mr. McKinney. So then could I assume that the likelihood that if any of the four shots that we heard were false alarms, that you could presume more strongly it is that third one?

Dr. Barger. I think you are looking for an indication of the power of the test to find a shot given that one may be quite different than another and would the different one be easier to find.

Is that the question, or am I completely off?

Mr. McKinney. I guess what I am really saying is that we seem to have three occurrences that are pretty similar--one, two and four.

Dr. Barger. Yes.

Mr. McKinney. And we have three that looks differently, sounds differently. I was just questioning as to whether or not that was the one that you could presume was most likely to have perhaps been something else, or perhaps been another occurrence, or backfire, or something.

Dr. Barger. I don't have the information to answer that. I don't know about other occurrences.

Mr. McKinney. Neither do I.

Dr. Barger. Like I know about test shots fired in Dallas. All I can say is that particualr sound on the tape sounded sufficiently like one of the test shots in Dallas to have scored above the threshold.

Mr. McKinney. But then if we were to accept that third shot as we heard it in the reproduction as a shot, it would have had to have come from the grassy knoll?

Dr. Barger. That is correct. If it occurred, that is where it came from.

Mr. McKinney. Not to get back into the game of probabilities, which we already played down the line, would you consider--is your probability on the third shot the lowest of the group?

Dr. Barger. Yes.

Mr. McKinney. Thank you very much.

The Chairman. The time of the gentleman has expired.

The gentleman from Tennessee, Mr. Ford.

Mr. Ford. Thank you, Mr. Chairman.

Mr. Chairman, let me ask a question to you and to the staff at this point.

Dr. Barger mentioned earlier, when you questioned him about the tape that we heard a minute ago. Knowing that they conducted an analysis of the police tape, and the tape that was done in Dallas with the experiment, just which tape did we hear a few minutes ago?

Dr. Barger. Was that my question?

Mr. Ford. I was asking--maybe the staff. Yes, I will raise the question to you.

Dr. Barger. What you were hearing were the sounds of four of the test shots recorded in Dallas three weeks ago, or whenever.

Mr. Ford. The tape that we heard a few minutes ago----

Dr. Barger. Yes. --was prepared by splicing together four of the shots that were recorded during the reconstruction.

Mr. Ford. So we are not talking about the tape from the police tape.

Dr. Barger. Well, we were not listening to it, that is correct.

Mr. Ford. I was under the impression that we were listening to the tape from the police tape of 1963, but we were not.

Dr. Barger. No, sir. If it had been that distinct, we would have followed an entirely different detection scheme that would have been much easier to explain.

Mr. Ford. Let me ask you another question.

From what you said earlier, are you able to point out what directions the shots came from? I mean, I recall earlier you talked about three shots and one shot, and you talked about different directions.

Are you able to pinpoint that down and, at the same time, not able to be specific about the three or four shots that were fired?

Dr. Barger. Well, we can only imply the direction of the shot by the location of the target and the gun for the test shot that matched. In other words, each time we get a match between the noises, the impulsive noises on the Dallas police take made during the assassination, and each time one of those noises correlates or matches with one of the echo patterns, we can only infer what the direction of the shot was by knowing what it was during that test shot. Otherwise-- that is the procedure.

Mr. Ford. All right. I was reading here that the team of scientists headed by you concluded that a reliable and credible conclusion could be determined if they could test and analyze in three crucial areas.

Then it comes over to say, you know, when you testified before this committee, that there you could testify whether or not there were three shots fired, or whether there were four shots fired on November 22, 1963.

So, we are not able to pinpoint that down at this point, is that correct?

Dr. Barger. The results of the tests are inconclusive to the degree that I described them, I believe, when I was answering Mr. Dodd's question, or Congressman Preyer--I am not sure whose question it was.

There is uncertainty in the results, as I described it.

Mr. Ford. I don't have any further questions, Mr. Chairman.

The Chairman. The time of the gentleman has expired.

The gentleman from Pennsylvania, Mr. Edgar.

Mr. Edgar. Thank you, Mr. Chairman.

Mr. Chairman, I have to admit that I am a little bit confused, and I would like to try to clarify some of what I have heard throughout today. Your testimony has been detailed. Let me just ask you this question.

Before you went to Dallas, before you went to Dallas to do the experimental test, you were more sure, I believe, of four impulses which you found on the original tape. That was one of the reasons why you came back to the committee to suggest that the test firings be held.

It seems to me that after the Dallas trip you seemed less certain of the four-shot indications that you received though the computerized acoustics. Why is that?

Dr. Barger. Because the tests that I had performed at the time that I spoke to the committee previously were the screenig tests that I described today. These are very weak tests. It is not particularly difficult to pass them.

You recall they had to occur at the right time of day, they had to have the total time span of five seconds or more, they had to have the right kind of distorted wave forms. There were six in total.

These were not very stringent tests. There were, in fact, four patterns, or four segments of the tape that had impulses on them that passed these weak, nonstringent tests.

The opinion that I intended to convey at that time was I could not rule out that the impulsive events in these segments of the tape were in fact gunfire because they had passed those six screening tests.

On the other hand, I said there was no way I could be sure that they were because the data were so noisy and that there was no way I could be sure, unless I could find out what echo patterns were in fact generated by gunfire in Dallas.

I produced that as a test that was the best one that we could conceive to determine whether those impulse patterns were in fact shots or not.

Mr. Edgar. As I remember it, you had a long roll of paper that you rolled out across a table for us.

Dr. Barger. Yes.

Mr. Edgar. And you were able to indicate four patterns of blips on your computerized paper that indicated something occurred in those four timeframes.

Dr. Barger. Yes.

Mr. Edgar. Do the four timeframes that are on the weak evidence--that is, the pre-Dallas evidence--corresponded to the timing, the minutes and seconds timing, that is listed alongside the four possible shots that you indicate in today's testimony?

Dr. Barger. No. The four impulse patterns that I had originally described, of the four, the first three proved to give us detections in this matching test that we performed. The fourth did not. However, we got two in the third that I showed you that time.

In other words, my indication of the general areas that might contain matches with gunfire sounds were approximately correct, but not in detail.

Mr. Edgar. Approximately correct, but not in detail. Was there one of those weak impulse areas that after going to Dallas you can discount as being a gunshot?

Dr. Barger. Well, yes, I think I understand that question. I showed four segments of the tape that had patterns that I thought might be gunfire, because they passed these six screening tests, and the last of those four did not subsequently prove to contain any.

Mr. Edgar. So that it was the third tentative weak gunshot that has now been divided into two possible gunshots?

Dr. Barger. That is correct.

Mr. Edgar. And you say it is a 50-50 chance that the fourth gunshot described up here is just a 50-50 chance, is that correct?

Dr. Barger. That is correct. I have insufficient evidence to state anything stronger or weaker than that.

Mr. Edgar. Is there any test that we could make that could reduce the uncertainty?

Dr. Barger. Congressman, the answer to that literally is yes. Now that the position of the motorcycle has been fixed with some confidence one would not bother with microphones all over other parts of Dealey Plaza, for example.

However, I believe that the advantages to be gained from rectifying that problem are very marginal, and I doubt if they could reasonably be expected to improve the level of uncertainty in the test.

Mr. Edgar. When I go home to explain what I have heard today to my 11-year-old son, who is in the seventh grade, what do I tell him?

Dr. Barger. How much time do you have? (Laughter)

Mr. Edgar. I have all of the evening dinner to explain to him what I heard. I am just trying to get it into a language that I can communicate with him.

Dr. Barger. That is a good question. I think the answer would go something like this.

There was, by a considerable measure of chance, amotorcycle in the motorcade with its radio in an operating condition, but with the motorcycle policeman not speaking about it.

The motorcycle was just open. Over that radio were heard a series of sounds, including the motorcycle, including other radios, and including the possibility of the sounds of the assassination of the President.

What you were observing today was the description of a test that was made on that tape to see if it was statistically likely to have contained the sounds of gunfire.

You found out that it was possible from this test to locate the position of the motorcycle with a good deal of confidence 15 years later. It turned out that the motorcycle was about ten feet short of the corner, at the approxmate time of the first gunfire, when the motorcycle noise in fact was observed then to abate, and the man slowed down.

You found also that motorcycle was in a position, found to be in a position, when the first shot was heard, that corresponded to the limousine being in the position where it was at approximately the time of the first shot.

For these reasons and others that I have described, there is good confidence that the motorcycle has been found. Therefore, good confidence that some of the shots have been correctly detected.

There is less confidence in questions of increasing detail, and I hope he enjoys the story.

The Chairman. The time of the gentleman has expired.

Mr. Edgar. Thank you.

The Chairman. The gentleman from Michigan, Mr. Sawyer.

Mr. Sawyer. I have been following the testimony reasonably closely, but I am somewhat perplexed.

You actually caused these shots to be fired in the same environment as the other shots were fired, with the same echoes and refractions and reflections and whatnot. So, you have a known--namely, your own--recording of what you knew were shots.

Now, were you able then, by comparing that to your oscillographic pictures of what was on that tape, to say what was on that tape were or were not shots?

Dr. Barger. Was able to----

Mr. Sawyer. --determine whether what was on that motorcycle tape originally were or were not shots, these disturbances?

Dr. Barger. We were able to determine that with considerable uncertainty that I have described.

Mr. Sawyer. You were not, then, able to determine at least to the point of forming a scientific opinion that those were shots?

Dr. Barger. It is my judgment, our judgment, the judgment of the team that did this study, that we have detected with about 95 percent likelihood, at least two of them, and on down the scale that I described for Congressman Ford or Preyer--I still can't remember which.

Mr. Sawyer. You have described now a number of times these probabilities. But let me ask you this.

I am not an expert, and no one else on this panel to my knowledge is, certainly in this type of thing. You have had a chance now to conduct the test, to examine the tape, to examine the results.

Do you have an opinion yourself, aside from any other evidence, based just on this tape, do you have an opinion as to whether there were three or four shots fired?

Dr. Barger. I have gone to some pains to present my opinion. I believe that I have presented the results of this test as clearly as I know how.

Mr. Sawyer. I understand all that, but now you have explained the pros and cons of the test. But laying aside any other evidence, you have now conducted the tests, and you have looked at the oscillograph of this motorcycle tape.

Now, do you as a professional in this area have an opinion as to whether or not there were three or four shots fired?

Dr. Barger. Congressman, I can't add any information by saying I think there are three or four. I believe the results of the test do not allow me to state with greater certainty than I have the answer to that question.

Mr. Sawyer. Well, then all I can say is I would hate to civilly sue anybody, let alone prosecute anybody, on this kind of evidence.

Thank you, Mr. Chairman.

The Chairman. The time of the gentleman has expired.

Doctor, let me go back for a moment and try and clarify something.

It appears to me that in answering both Mr. Dodd and Mr. Sawyer, when you make reference to the probabilities, that you group the four shots in terms of the probabilities. When you say that two of the shots, the probabilities are 95 percent; one, the probability is 60 to 70 percent; and that the fourth is approximately 50 percent.

Would you please individualize for us, and tell us which are the two where the probabilities are 95 percent, which is the one which is approximately 60 to 70 percent, and which is the one that is 50 percent.

Dr. Barger. Congressman Sawyer isn't going to like this answer, but the probabilities that I gave you are based on not distinguishing which three, which two. In other words, the high confidence that we have is based on the high degree of order in the detections, and that can be established by two, any two.

Mr. Sawyer. Let me say I anticipated the answer, Mr. Chairman.

Dr. Barger. If I might indicate possible mitigating circumstances for Congressman Sawyer, I do believe that even with this level of uncertainty, it is quite important to know when they occurred, if they did.

I can see that Congressman Sawyer is not convinced of that.

The Chairman. Let me ask you this. I would assume, then, from your former answer, that you are unable to identify what shot or impulses represented as the grassy knoll shot or impulse?

Dr. Barger. I think not. I don't believe that is a correct interpretation of the results. If the shot at that time, seven and a half seconds, indicated in green, stnads up, then it was from the grassy knoll--it would not have been from the Depository.

The Chairman. Now, I understand from your previous testimony that the shot which you simulated in Dealey Plaza from the grassy knoll was with a .32 revolver, or .38?

Dr. Barger. Well, the one with a pistol, yes. There was also a rifle fired from there.

The Chairman. Simultaneously, or separately?

Dr. Barger. No, separately. The tests include separate and distinct shots from rifles and from pistols, from the knoll.

The Chairman. Well, with reference to the istol, what caliber was that?

Dr. Barger. .38.

The Chairman. .38. And that is a subsonic or supersonic type of sound that eminates?

Dr. Barger. The particular charge in the bullet used made it a subsonic projectile.

The Chairman. The composition of the bullet gave you a supersonic result.

Dr. Barger. I am sorry. Yes, we were firing a subsonic projectile from that pistol.

The Chairman. All right.

Now, is there a different type of acoustical representation that you will get depending upon whether it is subsonic or supersonic?

Dr. Barger. Yes, there is. That is why we also fired a rifle from the knoll because it has a supersonic projectile.

The Chairman. I see. So that in terms of the simulation, and in the absence of any real knowledge as to whethr a subsonic or supersonic type of firing came from the grassy knoll, you are unable, with any real degree of certainty, of being able to say that is in effect a real simulation, aren't you?

Dr. Barger. If that one should stand up, that shot from the knoll matched with a rifle shot, and not a pistol shot. The match achieved with the pistol shot was very poor.

Therefore, it is possible with confidence to distinguish on that point, and it would appear that there was not a subsonic projectile fired from the knoll.

The Chairman. I just have one further question.

With reference to attempting to simulate the scene as you did, to what degree did the lack of a crowd such as there existed on that particular day in 1963 affect your simulation?

Dr. Barger. Well, it affected it very little because the sounds that are scattered from a person are of the sorts that I described earlier today, as scattered sounds. This is the weakest form of redirecting the direction of sound from a source and into a receiver.

Our thresholding procedure, which eliminated all of the weak sounds, both in the test pattern and in the police tape, was designed to eliminate the contribution of weakest companies such as those due to the presence of people.

The Chairman. I see.

My time has expired. Other members seeking recognition?

The Chair recognizes counsel, Gary Cornwell.

Mr. Cornwell. We have to leave you in a few moments, I am sure, Dr. Barger. We want to take away from your presentation whatever we can of a constructive nature.

You made a statement informally to me last evening which I think you mentioned previously in your testimony, but nevertheless, it might merit further explanation for just a minute.

That, as I recall, was to the effect that a scientist such as yourself can basically give us the data, and can to a limited degree provide us some insights about the probabilities of any one aspect of the data occurring by random chance, but that once you present us with the data, it is the committee's problem then to decide how to interpret it in the end.

Is that correct?

Dr. Barger. That is correct.

Mr. Cornwell. From your point of view, then, all you can do to help us unscramble the chart is to tell us what a mechanical, numerical calculation of some type, how it comes out, with respect to the random chances of various events occurring.

I take it there is no probability which will tell us how many shots occurred, or which were the real ones and the wrong ones in the end. Is that correct?

Dr. Barger. None that I know of beyond what I have mentioned.

Mr. Cornwell. All right. So what we must do, then, is take the data and see what external corroboration or impeachment can be applied to it.

Dr. Barger. That is my view, yes.

Mr. Cornwell. Just so that we understand what help you can provide us in that task, I would like very quickly to run through the chart and use it with some hypotheticals out of it. Let's talk about the top line of each of the four time segments.

In the first time segment, the top line is a microphone array, 25, a shot from a TSBD, down towards target one.

The second shot, the motorcycle's apparent location is moved from mike 25 to 26, slightly up the street, another shot from the TSBD, down to the street and the target, somewhere in the motorcade.

The next one, picked up with the microphone again slightly further down the street, a shot from the knoll, out to the motorcade.

Finally, another shot from the TSBD, motorcycle again slightly further down the street, pointed at the motorcade.

With respect to each of those four possible shots, apart from any probabilities, independently, we might say, they each occurred at the right time of the day, they each were unique in the data overall that you analyzed, they each occurred within a time span which did encompass at least five seconds, the shape of each of the impulses was what you would expect, the amplitude was roughly what you would expect, and the number of impulses or echo patterns in each were what you would expect from the geography of Dealey Plaza, is that correct?

Dr. Barger. That is correct.

Mr. Cornwell. With respect to each one, the strict probability that that one would have occurred on that tape through some random sound source would be identical, individually viewed; that is .8, .8, .8 and .8. Correct?

Dr. Barger. Well, the correlation coefficients were all .8, that is a fact.

Mr. Cornwell. The tape on which each of them appeared is, to the best of your knowledge, a genuine tape made in Dealey Plaza on November 22, or from transmissions on that date?

Dr. Barger. That is correct.

Mr. Cornwell. Each of those four items appear very close, near to the line which you would expect the motorcycle to be traveling; in other words, the rate that it would travel down the street in the procession at approximately 11 miles per hour.

Dr. Barger. That is correct.

Mr. Cornwell. And independently we do know that there wre shots fired in Dealey Plaza on the day at about the time that these impulses occurred on your tape.

Dr. Barger. Correct.

Mr. Cornwell. Then it would be the committee's job to apply independent evidence for each of those as an equal chance of being a genuine shot, to determine if it is genuine or if it is not.

Dr. Barger. That is correct.

Mr. Cornwell. I have no further questions.

Thank you.

The Chairman. Thank you, counsel.

The gentleman from Indiana, Mr. Fithian.

Mr. Fithian. One question, Mr. Chairman.

Can we say that the shots, as far as time sequence is concerned, that were fired in Dealey Plaza at any time during that stuck microphone, any time during that time frame, had to have occurred at the following relative sequence:

The first shot as zero, the second 1.6 seconds later, the third 5.9 seconds later, or at about 7.5 seconds after the zero time frame, and the fourth .5 seconds later, or at just shy of 8 seconds in the time frame?

Dr. Barger. That is correct.

Mr. Fithian. There is no other acoustical disturbance of the tape that could possibly be a gunshot?

Dr. Barger. We believe that the threshold that we set was low enough to accept all actual occurrences, and there were none others than those you just described, that is correct.

Mr. Fithian. If, therefore, there were any shot that did not match this time sequence--well, to put it the other way around, there could not have been definitively, could not have been a shot in this time frame that did not match one of those four interruptions?

Dr. Barger. That is correct.

Mr. Fithian. Thank you.

The Chairman. Dr. Barger, at the conclusion of any witness' testimony before this committee he is entitled to a period of five minutes under our rules in which to explain or amplify, any way expand upon his testimony.

I would like on behalf of our committee to extend five minutes to you at this time.

Dr. Barger. Chairman Stokes, I thank you for that. I suspect that everyone has heard quite enough of me today, and I will respectfully decline to speak at any greater length.

The Chairman. You have had quite a lengthy day here with us. It has indeed been a real experience for us, in not only working with you today, but previous occasions we have had to be with you, and to discuss the matter which we assigned to you for your investigation and analysis.

It has indeed been a pleasure to work with you and to have had the benefit of your testimony here today. On behalf of the committee, we thank you for having appeared here with us. You are excused, sir.

Dr. Barger. Thank you, sir.

The Chairman. At the request of Mr. Fithian, the committee at this time calls Mr. Paul McCaghren.

Mr. Blakey. Mr. Chairman, before Mr. McCaghren is interrogated by the committee, it occurred to me that it might be appropriate to clarify the record on one point.

Much of the emphasis of the committee's testimony has focused on the validity of the third shot in an effort to establish whether there were three or four shots. There is a time differential between the first and second shot that I believe was identified by Mr. Fithian as 1.6 seconds.

The issue that I would like to bring to the committe's attention is that the existence of the expert FBI testimony indicates minimum time in which a Mannlicher Carcano could be operated and correctly aimed was stated twice in the Warren Commission's hearings, once by Mr. Fraser, as a minimum of a possibility of 2.3 seconds--he said that was as fast as the rifle could be operated.

Mr. Shaneyfield, at a subsequent point in the record, indicated that his study indicated that the minimum the rifle could be fired was 2.25 seconds, for two successive well-aimed shots.

The committee staff has systematically made an effort to re-examine each of the underlying premises in the investigation that has preceded us, as that seemed to be the proper thing to do.

When the staff learned that the time differential between the first and second shot was 1.6, and thus well below what the FBI testimony had indicated was possible for one person to do operating one rifle, it obviously raised the specter of two riflemen.

Consequently, preliminary tests have been undertaken by the staff to evaluate the validity of that FBI judgment. I would report to the committee at this time the preliminary results of those tests.

I would emphasize, too, that those tests are an ongoing proposition, and the final results will be given to the committee at a later point in time.

The staff, on a preliminary basis, conducted a series of tests at the Lorton firing range under the supervision of Cecil Kirk, of the Metropolitan Police Department.

We learned that it was possible for a relatively untrained individual to operate a Mannlicher Carcano in considerably less than the FBI time.

One test resulted in one hit out of three at 150 feet in average times of 1.65 and 1.75. That is considerably under the estimate by the fBI.

A second test performed by another individual, who informs the staff he has not used a rifle in 25 years, was able to hit three out of three in a human silhouette at 150 feet in 2.125 and 2.0. Again, considerably under the FBI data.

I would bring that information to the attention of the committee in order that an improper inference not be drawn from that aspect of Dr. Barger's testimony that deals with the time sequence between the first and second shot.

As you indicated in the beginning of this hearing, all of the evidence is not yet in.

Another area where the committee will obviously have to take evidence is on the minimum time required for the operation of a Mannlicher Carcano.

If I may summarize, it would seem that the FBI assumption, the one employed by the FBI as well as the Warren Commission, of a minimum of 2.25 or 2.3 is questionable, and will have to be verified by the committee before a final interpretation can be made of the time sequence of the first two shots.

Mr. Dodd. Mr. Chairman, could I address a question to Mr. Blakey.

That test that we are performing now, is that being done with a Mannlicher Carcano?

Mr. Blakey. Yes. The committee is in the unique position of Congressional committees in that it now owns two Mannlicher Carcanos.

Mr. Dodd. Of the same?

Mr. Blakey. Of the same kind and style employed by Lee Harvey Oswald. I might add, Congressman--and I underline again the preliminary judgment of the staff is that the sharp differential in time may well be because the FBI experts were firing the rifle using the telescopic sight.

One clear implication of the expert testimony that this committee has received from its firearm experts is that that gun can be accurately fired using the iron sights, and the tests that were performed this last weekend employed the iron sights and not the telescopic sights.

Consequently, we were able, with very little effort, to sharply improve on the expert performance of the FBI.

Mr. Dodd. Can you tell me whether or not the FBI used the old Oswald rifle?

Mr. Blakey. The FBI did use Oswald's rifle in some of its tests.

Mr. Dodd. Is there particular reason why we cannot use the same rifle?

Mr. Blakey. I am told by our expert panel that there is some concern about the employment of Oswald's rifle. It has been in the Archives for a considerable period of time, and it has not been given the kind of attention that a hunter might give to his favorite weapon.

There may be some question as to whether that weapon may be dangerous to employ in simulated tests now.

Mr. Sawyer. Would the gentleman yield.

On the firing--and I didn't examine closely that Mannlicher Carcano that was here--is that scope so mounted that there is an option of using the iron sights?

Mr. Blakey. Yes.

Mr. Sawyer. So you can use either on it?

Mr. Blakey. You can use either the iron sights or the telescopic sights. The testimony, if you will recall, Congressman, of our ballistics panel, was that the choice that they would have employed would have been to have used the iron sights.

I might add that the Dallas Police Department sharpshooters who fired the two weapons in our reconstruction in Dallas in fact used open iron sights and were extremely accurate at that time.

Again, Congressman, I emphasize these are preliminary tests and they will have to be perfected at a later point in time. It seemed to us, though, potentially not the best introduction of evidence to simply allow the acoustics test to come in without some clarification being made of that time problem between one and two.

The Chairman. The committee calls Mr. Paul McCaghren.

Sir, will you raise your right hand and be sworn.

You solemnly swear the testimony you give before this committee is the truth, the whole truth, nothing but the truth, so help you God?

Mr. McCaghren. I do.

TESTIMONY OF PAUL McCAGHREN, PAUL McCAGHREN ASSOCIATES, DALLAS, TEXAS

The Chairman. Thank you. You may be seated.

Mr. Cornwell?

Mr. Cornwell. Thank you, Mr. Chairman.

Mr. McCaghren, what is your present occupation?

Mr. McCaghren. I am a private investigator and private security consultant in Dallas, Texas.

Mr. Cornwell. You have your own firm, is that correct?

Mr. McCaghren. Yes, I do.

Mr. Cornwell. What is the name of that firm?

Mr. McCaghren. Paul McCaghren Associates.

Mr. Cornwell. Previously you were a member of the Dallas Police Force?

Mr. McCaghren. Yes, I was.

Mr. Cornwell. During what period of time?

Mr. McCaghren. From 1953 until 1974.

Mr. Cornwell. And during that period of time, what was your rank?

Mr. McCaghren. I worked up from patrolman to detective in 1958. I was a lieutenant from 1960 to 1965 or 1966. I was a captain from 1966 to 1968. I was the director of the intelligence division in 1969. I was an assistant chief from 1970 to 1972. In 1972 I began to work my way back down. I was a captain, and I retired in 1974.

Mr. Cornwell. Would you just give me a brief statement about what caused you to begin to work your way back down in 1972?

Mr. McCaghren. A strong disagreement between myself and the then Chief of Police. Unfortunately, he was the Chief of Police and he busted me. If it had been the reverse, I would have busted him.

Mr. Cornwell. Directing your attention to 1963, what was the specific nature of your assignment during that time period?

Mr. McCaghren. In 1973?

Mr. Cornwell. 1963.

Mr. McCaghren. I was a lieutenant, burglary and theft at that particular time.

Mr. Cornwell. During 1963 or 1964, during the period of time that the Warren Commission conducted an investigation of the assassination of President Kennedy, did you as a member of the Dallas Police Force also have any role in that?

Mr. McCaghren. Yes, I did. I was with a group of about four or five lieutenants--we were commissioned to conduct an investigation of the events occurring at that particular time.

Mr. Cornwell. And particularly what were you investigating?

Mr. McCaghren. My particular investigation concerned the events that occurred in the basement of City Hall, regardling Lee Harvey Oswald and Jack Ruby.

Mr. Cornwell. And it was sort of a small special group that was working on that investigation, is that correct?

Mr. McCaghren. Yes, it was.

Mr. Cornwell. In addition to the question of Jack Ruby's entry into the basement, were there other issues that that group worked on?

Mr. McCaghren. Several, yes.

Mr. Cornwell. One of them perhaps being the shooting of Officer Tippit?

Mr. McCaghren. Yes, it was.

Mr. Cornwell. In connection with that investigation, did the group have an occasion to gather evidence?

Mr. McCaghren. Yes, we did.

Mr. Cornwell. At the termination of the investigation, do you know what was done with the evidence?

Mr. McCaghren. All the material in our possession was turned over to Chief Curry, who was the Chief of Police at that time.

Mr. Cornwell. Would you just basically tell us what types of evidence would have been contained in the package at that point?

Mr. McCaghren. These reports were not in-depth investigations. We were trying to field the hundreds of calls that were coming into the Police Department at that time. It was a cursory type of investigation. It was called to an abrupt half after about a month and a half. All of our reports were submitted to Chief Curry at that time.

Mr. Cornwell. So the material, then, would have perhaps included such things as tape recordings of the Dallas dispatcher tapes during----

Mr. McCaghren. Yes.

Mr. Cornwell. --November 22, 1963? I recall, for instance, there was an issue involved with the slaying of Officer Tippit of what was said that brought him into the area where he was killed, is that correct?

Mr. McCaghren. I am not that familiar with that particular aspect, sir.

Mr. Cornwell. All right. At any rate, the materials would include interview reports and various other things, is that correct?

Mr. McCaghren. Yes, sir.

Mr. Cornwell. Now, after the materials were gathered in the course of this investigation, and turned over to Chief Curry, when did you next come in contact with them?

Mr. McCaghren. I did not see the material again until approximately 1969. It was in 1969. Chief Batchler was then the Chief of Police. All of this material was found in a locked filing cabinet, in a metal filing cabinet, outside of his office.

He called me into his office and asked me how it got there. I did not know. I had not seen the material for years and years. He was very curious. Both of us were curious about how it got around to that particular place.

The filing cabinet had been abandoned and locked up. He had caused the lock to be broken. The filing cabinet had been designated to be disposed of. When he found the material, we reviewed the material. He gave the material to me.

His exact words were, ''Take charge of the material. Make sure that no unauthorized person comes in contact with the material.''

This is exactly what happened. I did take charge of the material. He was very concerned of the fact his predecessor had removed numerous articles from the Police Department----

Mr. Cornwell. And who is the predecessor?

Mr. McCaghren. --and published this in a book.

Mr. Cornwell. The predecessor you are speaking of is Chief Curry?

Mr. McCaghren. Chief Curry, yes.

Mr. Cornwell. So the materials were found in a locked file cabinet outside of the current Chief of Police's office, which of course would have been the former Chief of Police, Chief Curry's office.

Mr. McCaghren. Yes.

Mr. Cornwell. And you at that time were charged with the responsibility of safe-keeping them, is that correct?

Mr. McCaghren. Yes, I was the director of the intelligence division at that time.

Mr. Cornwell. What did you do with the materials to discharge that assignment?

Mr. McCaghren. At that particular time, I kept it in my office until approximately 1971, the latter part of 1971, early part of 1972.

Mr. Cornwell. And during that period of time, you had control of the documents, is that correct?

Mr. McCaghren. Yes, I did.

Mr. Cornwell. Or the materials. In 1971, what happened?

Mr. McCaghren. An outside agency, a private agency under the guidance of--Chief Dyson, Assistant Chief Fulgum and Assistant Chief Moore brought in an outside agency and permitted these people to go into our intelligence files.

They made pointed questions. They presented pointed questions to me about the absence of any files regarding the assassination. So, I just very quietly removed the files to my own private residence because I didn't trust the people.

I am talking about Fulgum, Dyson and Moore.

Mr. Cornwell. So you took the materials to your residence and stored them there, is that correct?

Mr. McCaghren. Yes, that is correct.

Mr. Cornwell. And for long a period of time did you maintain them at your residence?

Mr. McCaghren. Until 19--well, until this year. By chance I knew that one of your investigators had set up an appointment with a colleague of mine, and I asked to sit in on the interview.

When I was satisfied that he was who he said he was, then I told him that I had some material thta he would be interested in, and sure enough, he was interested in that material.

Mr. Cornwell. You turned over a great body of material to him. That was to Jack Moriarty, is that correct?

Mr. McCaghren. Yes, that is correct.

Mr. Cornwell. And included among the material was a tape recording and a dictabelt tape which we have been discussing here today?

Mr. McCaghren. Yes.

Mr. Cornwell. Now, throughout the period of time that the materials including the tape recording and the dictabelt were in your possession--in other words, continually from 1969, at which time they were removed from the locked filing cabinet--did you or anyone else tamper with the tape recording or the dictabelt?

Mr. McCaghren. No, sir. I had control of this property at all times, from 1969 until this year. No one, no one tampered with that material.

Mr. Cornwell. Thank you. No further questions.

The Chairman. Any members of the committee have any questions?

Thank you very much, sir.

Mr. McCaghren. Thank you.

The Chairman. You are excused.

Professor Blakey?

Mr. Blakey. Thank you, Mr. Chairman.

As the testimony today has indicated, the committee has examined motion pictures for jiggle, and tape for sound impulses in an effort to determine the number, time and direction of the shots fired at President Kennedy.

The committee has also considered the testimony of witnesses to the assassination itself. Specifically it sought to determine the extent to which ear-witness accounts as to the number and direction could be relied on.

For this purpose, the committee compiled all of the pertinent testimony taken soon after the assassination and had it subjected to psychoacoustical analysis, and all the testimony of 178 witnesses extracted from FBI reports and other Warren Commission documents stored at the National Archives that were studied, and statistically charted.

In addition, the team that performed the psychoacoustical analysis went to Dallas to witness the live firing in Dealey Plaza described earlier here today.

The purpose was to listen to the shots and get an on-the-scene feeling for their possible source and their magnitude.

The chief scientist in the ear-witness project is Dr. David Green. Dr. Green is a Professor of Psychophysics and Chairman of the Department of Psychology and Social Relations at Harvard University.

He received a B.A. degree from the University of Chicago in 1952, from the University of Michigan he received a B.A. degree in 1954, an M.A. degree in 1955, and a Ph.D. degree in 1958.

He has been a Professor of Psychology at the University of California and an Associate Professor of Psychology at the University of Pennsylvania, and an Assistant Professor of Psychology at the Massachusetts Institute of Technology.

Dr. Green is the author of numerous scientific publications, and he serves on the editorial boards of several scientific journals. He is a fellow of the American Psychological Association and the Acoustical Society of America.

At this time, Mr. Chairman, it would be----

Mr. Fithian. Would the gentleman suspend.

Just for clarification, Mr. Chairman, were we not going to ask any questions of Dr. Hartmann, or does that follow this?

Mr. Blakey. My understanding is that Dr. Hartmann will be called back to the stand at the conclusion of Dr. Green's testimony.

Mr. Fithian. Thank you.

The Chairman. The committee calls Dr. Green.

Doctor, will you raise your right hand and be sworn.

You solemnly swear the testimony you give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Dr. Green. I do.

The Chairman. Thank you. You may be seated.

The Chair recognizes counsel for committee, Lee Matthews.

Mr. Matthews. Thank you, Mr. Chairman.

TESTIMONY OF DAVID GREEN, PROFESSOR OF PSYCHOPHYSICS AND CHAIRMAN OF THE DEPARTMENT OF PSYCHOLOGY AND SOCIAL RELATIONS, HARVARD UNIVERSITY

Mr. Matthews. Dr. Green, would you begin by tracing the history and development of psychoacoustics in America?

Dr. Green. Well, the field of psychoacoustics I think, at least modern psychoacoustics, dates from the development of electronic equipment.

Certainly two key events in the development of the field were developments at the Bell Telephone laboratories, under

Dr. Fletcher, as well as the laboratory of psychophysics at Harvard University, under Dr. Stevens.

At those laboratories, various experiments were performed in connection with how people hear, and concerned with devices related to how they hear, such as microphones, and earphones, erplugs to protect their hearing, and the like.

The psychoacoustics lab during the Second World War was specifically charged with the problem of communications in airplanes, and so they did a great deal of work on radio sets and so on, in the course of that development.

Mr. Matthews. Would you give us some examples of how psychoacoustic analyses are conducted, and some of the conclusions that can be drawn from the experiments?

Dr. Green. I think probably most relevant to this committee would be a brief discussion at least of how we might find out how people localize sound in space.

For that purpose, a typical experiment would involve having two or more sources of sound and asking the subjects to differentiate or distinguish among the sources. So, we might sound one or another source and ask the subject to tell us which source was actually sounded.

Now, you will note that in these tests there is an element of subjectivity; that is, the observer or witness is obviously being asked a question about what he experiences.

But I hope you also note that you can score these tests objectively; that is, you can actually find out whether he can tell two sources are located a few inches apart at a certain distance.

So, by varying the physical parameters of the situation--that is, the distance, for example, between the sources or their distance from the observer--with composition of the sources--that is, the sounds they make or the loudness--you can begin to understand how the subject localizes sound in space and study the variables that affect this sort of behavior in an objective fashion; that is, in a fashion that any other experimenter could presumably repeat.

Mr. Matthews. Now, is that primarily a subjective test or are there objective aspects of it?

Dr. Green. Well, it is subjective in the sense that you use human observers and they make judgments. But your scoring of their responses is fundamentally objective; that is, we can all agree on whether the subjects get the correct or incorrect answer. So in that sense it is objective.

Mr. Matthews. Dr. Green, I want to call your attention to Exhibit 364 that has previously been entered into the record in this case.

First, are you familiar with that exhibit?

Dr. Green. Yes, I am. I remember this morning's presentation.

Mr. Matthews. Can you give the committee an explanation of how human beings recognize the sound of rifle fire?

Dr. Green. May I approach the exhibit, please?

Mr. Matthews. Certainly.

RPTR RUDOLPH

4:50

Mr. Matthews. May I also refer to Exhibit 357 previously entered and what has been identified as JFK-363.

Dr. Green. I will try not to be too repetitious, but I would like to review several aspects of the situation that are pertinent to how subjects localize weapon fire.

As Dr. Barger pointed out this morning, this is the pressure wave, that is, this is pressure on this axis and this is time. When a weapon is fired, if it is a supersonic missile, there is a shock wave produced. That is this little end blip. Then the muzzle blast comes in later which is the large explosive sound caused by gases coming out of the muzzle.

But the shock wave is of interest especially when you study the localization of sound because it causes confusion as to the locus of sound. That is best demonstrated on this exhibit where we have the rifle here at one instant in time. It has been fired and there is a bullet along this projectory, and as a result there is a shock wave or end wave that follows the bullet. There is also a blast wave traveling at the speed of sound away from the muzzle.

Now you should be familiar with roughly this sort of situation because if you will think of a boat traveling in still water, the surface wave or the bow wave of the boat is in fact like the end wave. The difference here is that this is a bullet going through air so this figure should be rotated completely around and there is a cone following the bullet that carries the end wave. Meanwhile, the blast is expanding in a circle about the muzzle, at least in free space.

Now if you take an observer in this position on the path of the shock wave, the shock wave which is a cone in free space passes over the observer in this direction. Therefore, it is as if the sound sweeps over him as if it were a plane wave striking, for example, if he is in this direction, both ears at the same time.

Therefore, the observer will tend to point at the path of the bullet. This is illustrated in this figure where the marksman is here and the bullet fired in this direction and these other lines represent the end wave at different times and the spectators pointing perpendicular to the end wave and at the path of the bullet.

This is a fairly good representation of an experiment carried out by Dr. Garinther at the Aberdeen Proving Ground. He had 30 or 40 subjects seated in an open field. The marksman was concealed in a truck and hence the blast wave was silenced effectively. He shot through the truck and down a path. The observers sat in this room and they actually pointed exactly as you would expect from this diagram.

This diagram also points out that while 75 percent of the observers point in a perpendicular to the end wave into the path of the bullet, 25 percent of the observers point in the opposite direction. This is called front-back confusion because the sound waves hit both ears simultaneously and you can't tell whether the source is immediately ahead or immediately in back of you.

Mr. Matthews. With the Garinther test, and Exhibit 363 is what you were referring to?

Dr. Green. I will have to look on the back to tell, but I think it was. Yes, it is 363.

Mr. Matthews. And the other exhibit that you referred to earlier is Exhibit 357?

Dr. Green. That is right.

Mr. Matthews. That contained the drawing of the shock wave and the blast wave?

Dr. Green. That is correct.

Mr. Matthews. Now what difference does it make in the position of the observer in determining that, either the origin of the shot or path of the bullet?

Dr. Green. Well, if the observer hears the blast wave as if he were located at a position here, this plane wave has an origin back here at the rifle. So he actually points at the source of the disturbance. So if the observer does not hear the blast wave, if he localizes on the basis of the end wave, he points at the path of the bullet, not the origin, in a way dictated by this geometry. That is perpendicular to the cone of the end wave and toward the path of the bullet.

So, for example, if the marksman were up here in that corner firing into that corner and we could not hear the blast of the rifle, that is, this is a gaseous spherical ray spreading out, and we simply heard the end wave, we would localize the source of the sound up in the ceiling.

Mr. Matthews. You mentioned in regard to 363 that Garinther conducted an experiment where the blast wave was concealed?

Dr. Green. Yes, the marksman was concealed in the truck. The blast wave was suppressed and only the end wave was evident.

Mr. Matthews. Were any of the observers able to accurately pinpoint the point of origin for the gunman?

Dr. Green. No, they all point along the path of the bullet, 75 percent of them. Now 25 percent will point to the opposite of that, in back of them, in the opposite direction.

Let me make one other point clear while I am at that diagram. That is, the relative contribution of the blast and end wave depends on where the observer is standing in space. If he is way down here along the path of the bullet, the blast wave is getting weaker and weaker but he is fairly close to the bullet so there is little diminution of the sound as it goes by. Because he is way down here in space there is a difference in time between the end wave passing and the blast passing, especially if you are located well down the path of the bullet, to hear the end wave and a long time later it is followed by the blast wave.

Mr. Matthews. Is there any position that the observer is standing relative to the origin of the shot, is there any greater possibility of him being able to locate the shooter?

Dr. Green. Yes, if he is located here at the side, then the shock and the end wave and the blast wave come at the same time and he would point at the origin of the source, that is, the rifle in this case.

Mr. Matthews. Can you give us some indication of the distance that the person would be from the origin of the shot, whether they would hear the end wave first and then subsequently the blast?

Dr. Green. Well down the line of the bullet. If they are well down the line of the bullet, the end wave will sweep over them first and the blast will come in later and in that case it would be very probable that they point at the end wave and ignore the blast as an echo. If they are off to the side, they will undoubtedly point at the source of the muzzle.

Mr. Matthews. Can you give us an opinion based upon how many feet that the observer would have to be standing, the origin of the shot, the end wave and then subsequently recognize the blast?

Dr. Green. I can't give you exact data on that subject because I don't think it has been studied in that detail, but let me review the considerations that apply.

The further he is from the bullet, the more the delay between the blast and the end wave.

So, for example, if he were 300 feet, the blast lag would lag the end wave, and if he were very near the end of the path of the bullet, the blast would lag the end wave by 150 feet. In that case, it is very probable that he would hear the blast very distinctly as the second wave.

Mr. Matthews. Mr. Chairman, at this time I move for the admission of F-363.

The Chairman. Without objection it may be entered into the record.

[The information follows:]

********** INSERT 7a**********

Mr. Matthews. Dr. Green, are there distinct sounds between the sounds of the end wave that you have described as the shock wave and that of the muzzle blast?

Dr. Green. Definitely, and you can see some indicaton of how these might sound by just looking at the exhibit on the far right.

The shock wave is very brief and the muzzle blast is very long in duration. Therefore, there is a great difference in pitch. The end wave sounds much higher in pitch than the blast wave. We have a tape that attempts to portray those two waves. It is a recording of firing in which we have excised from the tape examples of the shock wave and the muzzle blast.

If I may, could I play those to the committee and let them hear the difference between the two sounds?

Mr. Matthews. Yes, Mr. Chairman, at this time I would move for the admission of JFK-351 and JFK-352.

The Chairman. Without objection they may be entered into the record at this point.

[The information follows:]

*********** INSERT ***********

The Chairman. Mr. Green, would you explain to the members of the committee exactly what they can expect to hear from each of those exhibits?

Dr. Green. There are three blast waves, that is the larger wave in the far right exhibit first recorded. They are played three times. They are followed after a brief pause by three examples of an end wave played at the same peak over pressure.

Now, the intensities that you will hear in this room are nowhere near the intensities that you would experience if you listened to actual weapons. So you should recall that they will be much lower in intensity than anything resembling rifle or pistol fire, but nevertheless there are recordings of these two wave forms, and if we can have them at this time, you will hear three blast waves followed by three shock waves.

Mr. Matthews. Dr. Green, I believe you were present when the tape recording was played of four shots that were fired in Dealey Plaza?

Dr. Green. I beg your pardon?

Mr. Matthews. You were present in the room at the time of Dr. Barger's testimony when the recording was played of shots fired in the Dealey Plaza experiment?

Dr. Green. Yes, I was.

Mr. Matthews. How were those shots different from the shots that you played today on Exhibit JFK-F-351 and JFK-F-352?

Dr. Green. First of all, no one jumped in this room, and if rifle fire occurred in this room, I am sure it would have been quite loud. I played these because I wanted to show the qualitative difference between these two types of waves.

Mr. Matthews. Were you able to distinguish and separate the sounds you payed on those records without the use of special equipment?

Dr. Green. I am unclear as to the question, I am sorry.

Mr. Matthews. How were you able to obtain simply the blast itself?

Dr. Green. They were excised from actual rifle shots. We stood in a position where there would be a sufficient time difference between them and then cut them out of the tape and pasted them in the sequence that you heard them. So they are artifically prepared so it would be clear that three waves could be compared.

Mr. Matthews. Dr. Green, I want to call your attention to JFK-F-361 and ask you wether or not you recognize this exhibit?

Dr. Green. It is an aerial photography photograph of Dealey Plaza.

Mr. Matthews. On August 20 of this year you had occasion to be present at the time of the acoustic analysis testing in Dealey Plaza?

Dr. Green. Yes, I and two observers went to Dallas and observed during the sequence of shots that Dr. Barger has already described. The two observers were Professor Frederick Wightman, an associate professor of audiology in the Department of Communicative Disorders at Northwestern University and has had considerable experience in the field of sound localization and has contributed many papers and literature on that topic.

The other observer was Professor Dennis McFadden of the Psychology Department of the University of Texas at Austin. He also has a long history of research in the field of sound localization and has contributed many papers on that topic.

Mr. Matthews. Now, the purpose of the three of you being there primarily was to determine what the witnesses heard who were spectators of the Presidential motorcade on October 11, 1973; correct?

Dr. Green. That is correct. We observed in several different locations within the Plaza and compared the apparent locus of the sound and blasts that we heard and attempted to correlate them with reports gleaned from the witnesses, from the spectators, after the assassination.

Mr. Matthews. Dr. Green, I want to call your attention to JFK Exhibit F-344 and F-337, both of which have previously been entered into evidence and ask you to approach the podium and indicate the relative position that you and the observers stood in and the reasons why you selected that particular position.

Dr. Green. You will recall there were three sequences of shots that were going to be fired and for the first sequence we were situated about in this position on the grassy knoll, about halfway down the slope corresponding about there in this position.

We decided for the first sequence that the observers would stay together, that is, I had them located about three feet from one another and as they filled out their responses to each of the test shots, I would check their responses to see to what degree they were consistent.

As a result of this first sequence it was apparent that they were very consistent and that we could gain more information by splitting the observers. So for later test shots we observed some of the test shots together right under the Texas Book Depository in the second sequence. For the third sequence of shots Professor Wightman and I were situated down here and Professor McFadden was situated in the railroad overpass in about this position in this exhibit while these sequences were fired.

Mr. Matthews. During the course of the first sequence what degree of accuracy was there between the two assistants?

Dr. Green. There were 12 shots shown in the sequence, but because there were 5 test shots preceding, there were a total of 17 shots fired and the observers, Wightman and McFadden, as they rated them, they were in agreement on 34 percent of their responses. Their locations were the same, their reports of reverberations were identical, and their reports of the loudness were identical.

Mr. Matthews. Now, at the time the shots were being fired, what position was the rifle in?

Dr. Green. I knew this key but even I was somewhat at a loss to know where we were within the sequence because there were test shots preceding the sequence to get me out of step and occasionally some of the shots would be fired because the recording equipment was malfunctioning or something and

I was not in communication with anybody concerning the number of the sequence during the shots so they were essentially unaware of what shot was going to be fired next.

Mr. Matthews. Explain to the committee exactly what they heard in the process of those tests.

Dr. Green. Well, they were seated here in the first sequence, and the first shot would be out here on target one. Immediately thereafter they would write down where they thought the shot occurred, a comment about any other apparent echoes or confusion that might have occurred, rate the loudness of the sound, and any other comments that they thought pertinent.

As I say, they agreed in that first sequence virtually 100 percent of the time. There was one shot that McFadden heard, it was the second shot at target 3, and he localized that over at this old courthourse, if you draw the path of the bullet and put the end wave and that pointed at the old courthouse. That was a single response that I differed from Dr. Wightman on and the only one he was inaccurate about.

Mr. Matthews. When each of your assistants stood in the assigned places, did it make any difference which direction they were facing at the time of the shots?

Dr. Green. Not so much in this position, but when you are situated immediately under the Texas Book, which was the general location for the second sequence of shots, two things are rather confusing.

First of all, the end wave comes right over your head so you tend to localize the source directly over your head or on occasion you localize the source in whatever direction you were facing so you could, for example, move your head.

I once looked down Elm Street in this direction fairly well convinced that the sound came from this direction, and the other observers pointed their heads in different directions and said that influenced their judgment.

Also, in this location the sound sweeps down the building and the apparent source is rather large, probably because it scattered off the building.

Mr. Matthews. At any time during the testing did your assistants confuse the sounds of the end wave and blast with any sounds of echoes, reverberations?

Dr. Green. They certainly made some inaccurate responses. I would say of the order of 10 percent, and most of those could be accounted for on the basis of the confusion of the blasts and the shock wave.

On other occasions, for example, in this location where we are a good distance from the sixth floor window of the Texas Book Depository, and that is the source of the rifle blasts, it is fairly evident here to hear both waves actually occur. They occur in a sufficient delay from one another that Wightman, for example, is writing down that the end wave would appear somewhere in the air over the knoll and the blast would come from the Texas Book Depository.

Mr. Matthews. Now what is it that you had your assistants identify, both the end wave and the muzzle blast or just the rifle shot?

Dr. Green. They tried to report what they heard and also tried to make a guess as to what was the location of the actual weapon, but in this case it was just very easy for Wightman to distinguish the two so he kept writing down on his score sheet that the click, the end wave, appeared to have a locus somewhere over the knoll.

Standing here the end wave was coming down and hitting targets down here, or in the case of of the Main Street shots, way down here, so he would localize it up in space there. Then he would comment that when the blast came in, that came from the Texas Book Depository.

Mr. Matthews. They were identifying each of the sounds they heard?

Dr. Green. Yes.

Mr. Matthews. It may have been two sounds----

Dr. Green. They also commented about echoes, et cetera. In this position from the knoll, we were sufficiently up the knoll, that they heard a very strong echo off the post office annex that came in about a second later. In this position you hear a very strong echo off the triple underpass and McFadden in this position heard a strong echo off this array of buildings off Houston Street.

Mr. Matthews. Which of the assistants did you have standing in the area south of the TSBD Building?

Dr. Green. I stood there with Wightman.

Mr. Matthews. And the area immediately north of that known as the grassy knoll?

Dr. Green. All three of us stood there for the first sequence of shots.

Mr. Matthews. What did they observe at that time as to the sequence of the shots?

Dr. Green. With the exception of McFadden who we think confused the end wave and pointed to the courthouse, they all scored 100 percent, that is, they could correctly locate the source of the sound. Any rifle shot was quite evident. It was a very, very loud sound. You almost jumped when the rifle was fired from such a close distance. We were within probably 30 to 40 feet of the muzzle blast. The pistol was quieter and it was subsonic so it did not produce an end wave. It was extremely easy to localize because it was such a relatively small sound compared with the massive blasts of the rifle.

Mr. Matthews. Mr. Chairman, at this time I move for the admission of JFK-361.

The Chairman. Without objection it may be entered into the record at this point.

[The information follows:]

********** INSERT **********

Mr. Matthews. Dr. Green, what were some of your first research and analysis in this case?

Dr. Green. The first work I did was, I looked at a statistical survey prepared by Josiah Thompson from his book, Six Seconds in Dallas--I think that was the name of it--in which he compiled some of the witness' testimony as to the locus of the shots. I was slightly confused concerning that analysis and somewhat doubtful of it because given what I have tried to review concerning the apparent location of weapon firing, he had a very few percentage of his respondent's recording anything other than the Texas Book and the knoll as the potential location of the rifle.

Sixty-six percent in his analysis reported they didn't know, when only 3 percent reported that any other location other than the Texas Book or the knoll.

Mr. Matthews. Mr. Chairman, at this time I would move for the admission of JFK-360, the chart that was composed by the committee staff. I would add, Mr. Chairman, that it was composed based upon the number of witnesses at Dealey Plaza whose location could be pinpointed and who could give pertinent information relating to the number of shots and the spacing of those shots and the origin of those shots.

This information was taken from the official files and reports of law enforcement agencies and from testimony before the Warren Commission.

The Chairman. Without objection it may be entered into the record at this point.

[The information follows:]

********** INSERT 7b**********

Mr. Matthews. Dr. Green, I direct your attention to JFK Exhibit 360. Are you familiar with that chart?

Dr. Green. Yes, that is a chart I prepared based on the analysis that you provided. Along the columns of the matrix there are reports on the number of shots the witnesses heard.

For example, along the top some of the witnesses, 17, reported that there were two shots out of a total of 178. The vast majority, almost 77 percent, 132 out of 178, reported that there were three shots fired. Along the rest of the matrix are the list of the place of the origin of those as reported by the spectators, that is, the Texas School Book Depository was pointed to by 46 out of 178 respondents. The knoll was pointed to by 20. The other response, that is, other than the knoll or the Texas Book, 29 spectators, and 76 subjects, about 44 percent, reported that they did not know the location of the shots.

Mr. Matthews. Would you make a comparison of the data obtained in this research and the results of the information obtained from your field tests, can you make a determination of which of these witnesses would have been correct in localizing the shots?

Dr. Green. No, I don't think you can, for the reasons that I tried to outline earlier because a variety of determinants actually influence the apparent judgment that you make depending on in some cases the way the subject was facing, in other cases whether he heard the blast or the end wave and made his localization judgment based on the former or the latter.

What I have tried to do in the entries in that table is to test the assumption that there is essentially independence between where the witnesses point as the origin of the shot and the number of shots that they report.

So what I have done in that table is essentially assume that the two judgments are completely independent and try to predict how many subjects would fall in each cell of that matrix on the basis of that assumption of independence.

So, for example, using that assumption in the upper lefthand corner there, you see there were three subjects that in fact pointed at the Texas School Book Depository and reported they heard two shots when under the assumption of independence you would expect 4.6 to be the number, et cetera.

You can see by the close correspondence between the numbers in brackets and the bold numbers above them that you can essentially assume independence between the two types of judgments. If you entertain the hypothesis that only people who could hear that the shot came from the knoll might be expected to hear the fourth shot, the three others coming from the Book Depository, you might expect that assumption of independence would be violated, but as you can see, there is no evidence in that table to indicate that that is the case.

Mr. Matthews. Now after completing the research analysis in this case and the field tests, have you had an opportunity to confer with your associates in this matter?

Dr. Green. Well, after the tests, we discussed for three or four hours what we had heard and talked about what we had heard with respect to the reports that we had seen from the spectators.

I also drafted a preliminary report which they have seen and essentially concur with. I think we are in general agreement about the results of this test.

Mr. Matthews. Based upon that research, will you give your opinion to the committee as to final conclusions?

Dr. Green. I think the first conclusion is that we were very surprised at the loudness of the sounds that we heard. We had read reports from the spectators of firecracker-like sounds and the like. These gunshots were truly enormous in intensity, as you could see from some of the numbers that Dr. Barger reported this morning, the peak overpressures of these waves are indeed enormous.

I might add that throughout the first and second tests we attempted to simulate some of the noise in the Plaza by running a motorcycle. Actually, we had three motocycles present and we ran the motocycles to provide masking noise during the test, but it soon became apparent that the motocycles were unnecessary. They did not mask any of the important sounds we observed. The rifle blasts clearly overcame them. They simply prevented us from having conversation with each other so we dispensed with them in the latter sequence of tests.

We are simply unable to offer any explanation for why some of the observers reported these relatively small sounds when we know the intensities and loudness produced by the rifle blast.

There were several hunters who were observers who reported rifle blasts, but there were several others who reported the sounds to be extremely small.

The second conclusion would be to comment again about the consistency of the observers. They were extremely consistent in their responses. In general they were fairly accurate, probably in the 90 percent range. This may be due to the fact that they are well practiced in this sort of task. It may also be due to the fact that they knew that the rifles were going to be fired, whereas the spectators were caught largely unaware, or it may be due to the emotional response of the subjects that occurred after the first or second shots were fired.

Unfortunately, I know of no research and no evidence that would indicate how that would affect their judgments so I simply cannot comment on those differences. But our subjects, our witnesses, were remarkably consistent.

The third thing I would mention is that there are strong reverberations and echoes present in the Plaza. For the most part, these did not cause confusion among our witnesses because they occurred sufficiently late in time so that they were clearly recognized as echoes, the echo off the post office building arrived about nine seconds late and was just clearly an echo off the post office building.

Probably a more potential source of confusion was the echc off the railroad underpass, especially when you are located under the Texas Book Depository, because the end wave coming over your head out of the Texas Book Depository is very confusing so you are sort of startled and nothing makes much sense, especially if you think the sound is right up above your head.

So the first sound that comes in that is at any object on the ground comes from the railroad underpass. I think I also commented that from the railroad itself there are strong echoes off the buildings on Houston Street.

A fourth thing I would comment on, any sort of a knoll shot, rifle or pistol--and these were both unsilenced weapons, but I am not sure that makes a great deal of difference--any sort of knoll shot when observed from at least several locations, particularly the knoll itself, immediately across from the knoll, and to some extent below the Texas Book Depository, is a very easy place to localize sound. That is a shot from the knoll is usually heard as a shot from the knoll.

There were few errors on that. In fact, I don't think there were any errors on that particualr shot. So if there was a shot from the knoll, it is extremely easy to localize it at the knoll.

Finally, I would like to make one observation that I think is slightly inconsistent with the argument that there were three shots from the Texas Book Depository and one from the knoll. That is, that if there were indeed any shots from the Texas Book Depository and at least one from the knoll, one might expect, since these judgments are not all that difficult, that many subjects would report two sources for the locus of the shots, that is, they would report both the Texas Book Depository and the knoll as places where weapons were fired from.

If you go over the statistical survey of the 178 observers who gave reports, there are exactly four that mentioned dual locations, that is, that say the locus of the shots came from two places. I find that a strikingly low number given the hypothesis that the weapons were actually fired from two places.

We found that it was comparitively easy to localize knoll shots, at least from the knoll, and across from the knoll and to some extent under the Texas Book, and there was little doubt in the vicinity of the Texas Book that a shot was fired from that building.

I think that concludes it.

Mr. Matthews. Does it make any difference in localizing the origin of the shot where the target was?

Dr. Green. It changed the character of the sound somewhat because in various locations you would either be encompassed by the end wave or not, that is, you would be within the cone of the end wave or not. So I would not say that it did not make any difference, but as to the localization response, it generally was not terribly important.

Mr. Matthews. Mr. Chairman, I have no further questions.

The Chairman. The first questioning of the witness is to be by Mr. Fithian. We have a vote on the floor. So I think we will recess for about five minutes and then we will resume questioning the witness.

[A brief recess was taken.]

Mr. Fithian (presiding). The committee will come to order.

Mr. Matthews?

Mr. Matthews. Mr. Green, you were present during the course of Dr. Barger's testimony, and if you recall, he said that some of the shots fired from the TSBD Building were from a position within two or three feet of the window.

What effect would that have had on the witness' opinion of the shots?

Dr. Green. The intention of that manipulation was to suppress to some extent the blast wave and make the end wave more noticeable compared to the blast wave. I would say it was marginally successful, but perhaps because of the sophistication they all reported they generally heard the blast with some minor exceptions.

When Max McFadden was on the railroad overpass the furtherest distance from the Texas Book Depository, and the target was No. 4 which is almost again the railroad overpass down there on the bottom, he was often confused and heard a source directly on Maine Street he said, independent, or at least from all the shots from the Texas Book Depository.

So I am not sure what he heard, whether he heard an end wave--the end wave would have terminated by the time. It didn't sweep over him but some part of the end wave may have reached him, but in any case he made that observation.

But for the most part, it would be difficult to detect from the data itself whether the manipulation of moving the rifle muzzle back had any effect. It was our impression that it made the end wave more evident, but whether we knew that should happen and therefore heard it or whether it actually happened I am not sure.

Mr. Matthews. Thank you, Dr. Green. I have no further questions, Mr. Chairman.

Mr. Fithian. Dr. Green, with regard to the original ear witnesses, I had to step out for two votes and perhaps you covered this, but I am curious to know whether or not you can tell us anything about the probability of accuracy of those individuals.

Dr. Green. I did comment on that while you were gone.

The short answer is: I can't contribute very much. All of the experiments that contribute to our knowledge about localization are done in these rather routine and repetitive tests where you essentially put two sound objects at some distance, play one or the other, and ask the subject to tell you which one occurred.

So in these cases the subject is always well aware that there are a limited number of sound sources and he knows which discrimination he is supposed to make and he makes it over and over repetitively. Whereas, in the situation we are talking about here, of course, everybody was surprised by the first shot or nearly everybody. I really can't say what effect that would have. There is no available literature on that sort of situation and it would be largely speculation on my part.

There are some experiments where the range of signal alternatives is not known to the subject. In this case these are detection experiments, trying to detect a weak sound in noise, and the fact that the subject doesn't know which sound to expect does not make as much difference as you might expect. There is a decibel difference in terms of that.

Mr. Fithian. There has been a great deal of testimony by individuals and not a little literature indicating that a fair body of people who identified the sound indicated that the sounds came from two different directions, a very significant number as I recall, 40-some, testified that they heard shots which came from--and they pointed or otherwise indicated what came to the Texas School Depository window, and something in excess of a half dozen identified the grassy knoll and in fact some policemen apparently took off toward the grassy knoll and other eyewitnesses said they saw a puff of smoke from the grassy knoll, et cetera.

What I am trying to elicit from you is any help your expertise can give us in sorting out the validity of the ear and eyewitness testimony that we have in the Warren Commission report.

Dr. Green. Let me go back to your first statement because

I think we seem to be in disagreement about facts if I heard you correctly.

There were very few subjects who reported two locations were the source of the sound. I know of only four in the list of 178 that I looked at. There were a large number of subjects who reported they didn't know or were confused by the echo's reverberations, et cetera.

I have tried to point out that the rifle blast particularly, because of the end wave, creates a very confusing acoustic simulation and you are liable to point at the end wave. When you reach a conclusion whether that makes any sense or not is another matter.

You can point at the sky if you were down in the street level and the path of the bullet goes over your heard and I think you would then report you don't know the source of the sound because it is very confusing for the sound to be up in the sky. If you take a single subject out of the Plaza and ask me on the basis of his report would he be likely to be more accurate than any other subject, I simply could not say there is any more likelihood that one subject would be more accurate thn another.

Mr. Fithian. If you will suspend for just one moment, Dr. Green, I would like to have entered into the record JFK-F-362 and have it displayed on the easel for a couple of questions of the witness.

[The information follows:]

********** INSERT 7c**********

Mr. Fithian. Now, Counsel Cornwell, in the preliminary analysis made of this chart there seems to be some confusion about the numbers. Could you first of all clarify, since the total of 90 in the lower righthand corner does not equal the total number of ear witness accounts we have, how exactly this chart was constructed?

Mr. Cornwell. The difference between the two charts, first, is that the chart that Dr. Green has previously made reference to includes persons scattered all over the Plaza. The second chart has a more limited function. It was designed to facilitate direct focus upon the reported origin of shots from those persons who stood in the same areas of the Plaza that Dr. Green and his listeners stood.

Therefore, the figure ''90'' in the chart which was just put up is a smaller number than the total number of observations, 171, reported in the earlier chart. The 90 figure is a very restrictive one. It is taking the basic four areas that Dr. Green's listeners stood, namely, in the grassy triangle, on the knoll, in front of the TSBD, in front of the railroad overpass, and in Elm Street, and simply selecting those people who were in those areas and reporting what they said for each of the areas the shots originated.

Mr. Fithian. Now, Dr. Green, whether we use your figures, that is, the figures in the chart already introduced, or the one just introduced, we get several people, seven in the latter and I believe twenty in the former, who identified the grassy knoll as the source. Is that correct?

Dr. Green. That is correct.

Mr. Fithian. From all you know about where the shots were fired and applying the science of your training, could that many people, considering where they were located, identify the shots as deriving from the grassy knoll in the absence of a shot from that area?

Dr. Green. In my opinion, easily. Certainly the long shots, expecially if you take those subjects that are further up Elm toward the Book, could have very easily confused the end wave. The end wave is in front of them.

They make a front-back confusion and point to the knoll.

You can also make that judgment--incidentally, there were only about, I counted a total of something like 10 subjects that stood on the knoll or in that general area. I am a little more generous in my definition of knoll than this chart that has been introduced. But there are about 10 that report that. There are people all over the rest of the Plaza that also report the knoll. There are two or three in the Book, several at the triangle, one on the railroad tracks, a couple by the courthouse, et cetera. I don't find it surprising that some of those people, that is, a relatively small percentage, could point at the knoll despite the fact that nothing was fired from the knoll.

What I do find more surprising is what I stated as my final conclusion, that if there was somebody firing from the knoll, and we also found it easy to identify any shot from the knoll, and anybody who was firing anyplace else, why more people didn't hear both shots. As I said, only 4 out of the total of 178 heard two shots as the locus.

Mr. Fithian. Thank you.

Does counsel have any further questions?

Mr. Matthews. I have none, Mr. Chairman.

Mr. Fithian. With the possibility that those who dahsed out to vote on veteran's preference might want to recall you, I think we will excuse you now.

Under the rules of the committee, you are entitled to five additional minutes to clarify, amplify and in any way modify your testimony here today.

Dr. Green. I have had plenty of time. Thank you very much.

Mr. Fithian. Thank you.

Dr. Green, just before you move away, I am not sure whether Congressman Dodd has any questions or not.

Mr. Dodd. I don't immediately, but I know both the chairman and Judge Preyer are coming right in.

Mr. Fithian. Why don't you just remain seated there and let's bring Dr. Hartmann up.

I would like to ask the staff to put up the appropriate jiggle analysis charts that we used this morning. I think they are unnumbered.

Mr. Cornwell. I think they are No. 177.

Mr. Dodd. Mr. Chairman, before you move on, maybe I could address a question to our last witness, if I could.

Dr. Green, as I understand it, you earlier testified that with respect to any one subject, you could not say whether or not he or she would be more or less likely; is that correct?

Dr. Green. That is correct. I think I stated if you took a single subject out of the Plaza and asked me if he or she were more or less likely to report the locus of the shot, I could not be able to say.

Mr. Dodd. Are you familiar with the testimony of Governor and Mrs. Connally when they testified before this committee several days ago?

Dr. Green. I have read a newspaper report of it.

Mr. Dodd. Just to refresh your memory, they indicated they felt quite clearly that the shots came from their right rear. What I am asking you is: Based on the statement that I just read as what I understood to be a paraphrase of your feelings, whether or not your inability to make a judgment on individual accuray precludes aiding this committee in making a judgment on the accuracy of both the Governor's and his wife's statements as to the number of shots in addition to the direction.

Dr. Green. I am glad you brought that up because I looked at my testimony and see I didn't say much about the number comparing them with the locus and that is because I know of practically no literatue on that topic. Experiments with loud sounds and subjects, guessing the number of such sounds are, to my knowledge, lacking. So I don't really know what to say about the accuracy of those numbers. I have no way of giving you even a rough guess as to the accuracy.

I have heard informal reports that sometimes they are very inaccurate. My initial impression, looking at those numbers, was that the high numbers were confusion with echoes, that is, there was one subject who reported 8 shots and I presume he simply confused some of the echoes off some of the buildings.

But I could not really tell you how accurate the judgment of the numbers is. I know of no literature on this.

Mr. Dodd. And you are stating for us as well that to the best of your knowledge there is no body of knowledge or information that we could seek out that would assist us in making that kind of an evaluation dealing with numbers now?

Dr. Green. Not to my knowledge.

Mr. Dodd. Fine. Thank you very much, Mr. Chairman.

The Chairman. Does counsel have anything further?

Mr. Matthews. No, Mr. Chairman.

The Chairman. Dr. Green, at the conclusion of a witness' testimony before our committee we extend him five minutes in which he may in any way explain or amplify or expand on his testimony in any way. I would like to extend five minutes to you at this time for that purpose.

Mr. Dodd. If I may, Mr. Chairman, before you get that chance to refuse that offer, I asked you about direction and number. I also wanted to ask that same question with regard to the Governor and Mrs. Connally's statement about direction of shots.

Dr. Green. The thing that makes my testimony, the subjects that I took to the Plaza were extremely accurate. They did not find these discriminations difficult.

The question I think at issue is they were expecting the shots, they knew they were coming. They didn't know the order but they knew they were coming from two locations. They were trained observers. If you have a subject that is unprepared for a shot, that is quite a different issue. I don't know how to extrapolate for that subject. I have commented that there is no available data for that situation. There are certain locations that are best for observing certain shots and in the general region of the Book Depository, right on the street beneath it, in our opinion it was extremely easy to tell it came from the Book. There was a massive sound to the right and rear that sort of crawled down the building, presumably due to scatter on the regular surface of the building and it was quite evident.

So I am not at all surprised at Governor and Mrs. Connally's report, but I can also look at the charts and there were other people standing there, some pointing at the knoll when that event occurred apparently.

So I can't tell you what circumstances led to that judgment other than to suggest that this is a complicated stimulus, that it depends in that location somewhat on where your head is pointed, for example. These other factors could enter the judgment.

Mr. Dodd. Fine.

Thank you.

The Chairman. Dr. Green, you have five minutes.

Dr. Green. I have already refused your kind offer once and I will do so again.

The Chairman. All right.

Well, thank you very much for appearing here and giving us the benefit of your testimony. You are excused.

The Chair now recognizes Mr. Fithian for further examination of Dr. Hartmann.

Mr. Fithian. Dr. Hartmann, I really don't have very many questions and I don't think it will take long.

Are the jiggle analysis techniques used by yourself and your associates for your presentation here today common interpretation techniques? In other words, what I am asking is: Have they been used to help interpret photos and films other than those from Dealey Plaza?

Dr. Hartmann. I think the correct answer is no. In fact, I would like to emphasize that unlike much of the scientific data that you are getting such as on the acoustic work or the neutron activation analysis, this kind of technique does not have some scientific tradition of routine measurements, you do the measurements this way, this way, this way, and you get such and such an answer.

Here we were making a common sense hypothesis at the beginning, meaning based on our common experience that a person is likely to react and the best information which I mentioned in my testimony indicates that people do react to that sort of thing and we try to measure the film to see if there was a reaction, looked at each step as we went along and got the results I showed you.

Mr. Fithian. To the best of your knowledge did the Warren Commission employ this technique?

Dr. Hartmann. I believe they did not. I think that the frame 210 that they identified was identified solely on criteria of some FBI agents estimating when a wound occurred and also that they constrained their shot times by this tree which grew in front of the window. They tended not to want to call for a shot when the President was behind this tree.

Mr. Fithian. Let's take the Zapruder film and give me the best estimate of your analysis. If any of the shots that were fired, whether they were three or four or two, if any of those shots were closer to Zapruder than the others, would you expect the blur or the jiggle or whatever the three of you were analyzing according to your own technique to be more pronounced than the more distant shots?

Dr. Hartmann. I am not sure I can give you a firm answer on the basis of any psychological theory about how the man would have reacted except to indicate one of my own observations.

I think I was the only one in the group that stood on Zapruder's pedestal. That is not far from where the others were in the sequence of shots just indicated. But I stood on Zapruder's pedestal during that sequence and the shots from the Depository, this is my framework, I am looking out at the street. I had a sensation of a very large sound filling the street at the location of the Depository but the shots from the knoll left my right ear ringing and my left ear not ringing.

So I had a strong sensation from that shot, so I would have expected the witness to be more definite that there was something to the right if there had been a shot fired there.

Mr. Fithian. Assuming that the intensity of the unexpected noise has something to do with the amount of reaction of the subject, which I take it is what you just said, is there anything that we can learn, looking at your chart, as to the possibility that any of the shots came from the grassy knoll?

Dr. Hartmann. I believe not because there are clearly reactions or jiggles. I should not say reactions because we don't know that every jiggle is a reaction to something. Some of the jiggles may be ordinary panning areas. There are clearly jiggles of different magnitude on there. What we don't know is whether there are several kinds of stimuli initiating jiggles.

By that I am trying to say that there is the classic involuntary startle reaction which is going to produce jiggles. There may be an emotional reaction following that caused by what the man sees through his viewfinder. There may be an emotional reaction caused by what he perceives is going on. The instant where he perceives there is actual gunfire going on may change his bodily reaction. I think it is very heard to say.

Mr. Fithian. Is that a possible explanation of the fact that clear over to the righthand corner of your own chart the disturbances are not only greater amplitude up and down, if you want to use that term, but more pronounced from their on out to the end of the chart?

Dr. Hartmann. Yes, I think we definitely have that. I should have said that earlier this morning. From 310 onward, which as you say is the righthand corner of those last three charts, Mr. Zapruder has recognized what happened and that is based on his own testimony, as I understand it. He said that he saw the wound, he saw the President's head exploded and he reacted very violently to that.

If I interpreted his testimony accurately, he began crying out shortly after that. As I read the testimony, I could not confirm he was crying out or speaking as he ran the camera, although he says he cried out something like ''They killed him'' at the end of the sequence. He said he reacted very strongly.

Mr. Fithian. So from your scientific analysis that first major one could have been started by a shot closer at hand

and therefore louder or by what he perceived through the lens. Is that what you are saying?

Dr. Hartmann. It could have been. One can get into the problem of whether there may be other gunfire buried in all that jiggle at the end. I don't think we can tell, but something clearly initiated that last sequence at 310.

Mr. Fithian. Just two small points: Did you view in any of the films that you viewed any motorcycles in the parade?

Dr. Hartmann. Are you referring to the question raised during Dr. Barger's testimony whether a motorcycle might have caught up to the car?

Mr. Fithian. No. I was asking whether you viewed any motocycles at all.

Dr. Hartmann. Yes, sir, clearly at the beginning of the parade you see the motorcycles coming around the corner and they stayed behind the car during the filmed sequence.

Mr. Fithian. During your analysis of the film did any of the motorcycles seem to be catching up or moving forward in their relative position in the parade?

Dr. Hartmann. Not by any substantial amount, no.

Mr. Fithian. Mr. Chairman, I have no further questions of the witness.

The Chairman. The time of the gentleman has expired.

The gentleman from North Carolina, Mr. Preyer.

Mr. Preyer. Thank you, Mr. Chairman.

I may have missed some of your testimony on the vote and I may be asking very similar questions, but from my understanding, does your jiggle analysis, when you match it with the Zapruder film, indicate a corresponding peak or reaction in your tape at the moment when President Kennedy was hit by two shots?

Dr. Hartmann. Yes. Of course, the jiggle analysis comes only from the frames in the film. I think the conservative interpretation of that second chart from the left, which is the summary chart, is that it shows a violent set of jiggles initiated after what we know to be the fatal head shot and that we could characterize an earlier group of jiggles around frames 190 to 200. We know that the President apparently responded to this back wound about a second after that.

So I think we could infer that those two sets of jiggles are connected with the two shots that caused the wounds.

Mr. Fithian. If the gentleman would yield, I wonder if we might not introduce into evidence Exhibit 177-A which I think would have applied to that last question and answer, but it has not been introduced yet today.

The Chairman. Without objection it may be entered into the record at this point.

[The information follows:]

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Mr. Preyer. So that that exhibit indicates clearly the head shot.

Dr. Hartmann. Yes. May I go over and----

Mr. Preyer. Surely.

Dr. Hartmann. If I may, to answer your question, I think I can summarize what I perceive is the situation that we have right now.

Derived from the film is the fact that the photographer jiggled his camera at these times. And if we first look at it in a very broad-brush sense, we see there is a cluster of jiggling going on here and a cluster going on here Those jiggles are fixed compared to what is happening in the motorcade and with respect to some time scale.

Now, floating free in space, or in time, on an unknown time scale, on a time scale which we don't know how it is connected to that diagram, is this spacing of shots, which the acoustics people have come up with.

The question is how do these fit. These shots could be anywhere along here. We can slide them along. But we cannot start this far back because then we don't have any shots up here to cause that first one. So we have to start sliding forward.

310--here is one--310 is right in here. So we know that there was a trigger pulled at that time. We could line up number three or number four. Number three has perhaps been questioned a little bit more, and there is no medical evidence that the shot that hit the head came from the knoll. So perhaps number four is the better line-up.

Mr. Dodd. Would the gentleman yield at that point.

Mr. Preyer. All right.

Mr. Dodd. You are stating with a pretty definitive assertion there that the trigger was pulled. What you are suggesting is not in fact that a trigger was pulled, but that something caused Mr. Zapruder at that point to wiggle the camera.

Dr. Hartmann. No, sir. I think we can say that the trigger was pulled, because we see in Frame 313 the matter ejected from the head, the head explosion. And in 314 it is flying on up. So if we run it backwards--314, 313, 312--the bullet is hitting the head. And then we have to allow about two frame flight time for the bullet.

On that basis I say that the trigger was pulled, a trigger was pulled at 310 plus or minus one. So I would say there must be some sound source starting at 310 plus or minus one.

Now, I would like to work it all the way back to the trigger being pulled, because presumably that is a fixed point in space, as opposed to tying it to impacts on the motorcade which is moving so that we have a firmer fix on it.

So let me say here is a time when there must have been a loud report originating from someplace. Presumably it is the Depository, because that matches the acoustic evidence.

Now, the correct number of milliseconds after that, a reasonable number of milliseconds after that, based on the startle reaction, psychological experiments that I quoted from the literature earlier this morning, a reasonable number of milliseconds after that the cameraman starts jiggling. So that makes sense.

Now, the situation is does it make sense up at that end. And in the very broad-brush sense, or if we put on our rosy glasses or diffusing glasses or something, I think you could say yes, the acoustic analysis says there are events up here at this end and the jiggle analysis says there are some events up here at this end, before 200, and not at 210, for example, and not between 210 and 313, which is where the Warren Commission tended to put shots.

So in that sense we have got something new, and we have got some agreement that something is happening up at this end.

And a final sort of broad-brush statement is that I think you will be hearing tomorrow, if I understand, in the testimony sequence quite a bit of interesting evidence, photo evidence, from other members of the photo panel, that a number of very interesting things happen up in here from about 160 or even 150 to about 200--people turning, people who were running along, stopping and looking, this kind of thing, if we watch the crowd action in the background.

So in that sense we have got new results and we have got something that looks interesting and is consistent.

If you now try to get into the detailed fitting of this jiggle pattern to one of these sounds, I think it gets a little bit more difficult.

There probably are several things to be remembered about that. One is there is some uncertainty attaching to the fixing of these times, as I understand it. Maybe a couple of tenths of a second.

That is what is meant when I drew these things as kind of fuzzy bars, that they are not just precise fixed instants. So you maybe get to slide this a little bit.

Maybe I can slide this one around our 310 fiducial mark. And the more I push it, the more unhappy the acoustic people would get presumably. But I can push it a little bit in that direction, and that moves it a little bit up in front of this jiggle, and that makes sense.

The other thing that you can consider is, is it possible that either the movie camera or the tape or both are running at a slightly different time rate than what we timed them.

The camera has always traditionally been timed at 18.3 frames per second. But could that be 19 or 17, something like that? Could it have been running at that speed that day?

We don't really know the answer to that. But that correction would have the effect not of shifting by a small uncertainty, but by pretending this thing was drawn on rubber and allowing you to stretch it or compress it by a small amount.

We have put our heads together about this and have thought that perhaps eight percent or something like that might not be unreasonable. And that would get you another ten frames or something like that up at this end.

So that you could imagine possibly stretching this thing so that these things moved another ten frames forward. If you did that, then you could start making a case that this shot initiated this jiggle cluster, perhaps even this shot initiated this jiggle here. It would be interesting to see. But we don't have any data, it is not here.

I might also just make a final comment, that all of this would make people who have looked at the previous assassination material I think be surprised, because no one has ever really considered very much the idea that there could be shots that early in the parade.

And I think the basis of that is you look at the parade and at first glance, the first fifty times you look at the Zapruda film you don't see very much happening there.

But I ask you to listen and see what is discussed, I believe, tomorrow.

Mr. Preyer. Well, is the jiggle analysis consistent with the firing of four shots or is it inconsistent with that?

Dr. Hartmann. I would be inclined to say that it is perhaps somewhat more consistent with the firing of three shots, without this one. It would perhaps even be more consistent with the firing of two shots, because there are two principal clusters here. I think it is rather weak evidence to answer that question.

Mr. Preyer. So it is more consistent with the firing of three shots.

Dr. Hartmann. Slightly.

Mr. Preyer. But it is most consistent with the firing of two shots.

Dr. Hartmann. I think it would be somewhat more consistent with the firing of two shots. I think this whole mass of material from today gains its credibility by being fitted together with everything else, rather than just being taken as evidence that proves anything on its own.

Mr. Preyer. How much of the reaction there is from Mr. Zapruda seeing President Kennedy struck and reacting, and how much is his jiggling from the sound of the bullet?

Dr. Hartmann. I think it is impossible to say for certain because we don't know how the human body really reacts. But Mr. Zapruda said that he reacted to the sight of the impact, of the head wound, as I understand it. And that certainly is consistent with this massive shaking that goes on after that.

By psychological experiments that have been done in the past, one would expect that in the first tenths of a second, though, there would be a startle reaction, and that is probably what we see particularly in Frame 318, the very blurred frame.

Mr. Preyer. Thank you, Mr. Chairman.

The Chairman. The time of the gentleman has expired. The gentleman from Connecticut, Mr. McKinney.

Mr. McKinney. No questions, Mr. Chairman.

The Chairman. The gentleman from Connecticut, Mr. Dodd.

Mr. Dodd. Thank you, Mr. Chairman.

You stated in response to Congress Fithian's question that the Warren Commission was in error in identifying Frame 210 as the frame in which the first gunshot was fired. What is your explanation for the Warren Commission's error?

Dr. Hartmann. Well, I don't know that I said so flatly that they were in error. But I would say that that evidence does not fit very well with what we have.

And again, my understanding was that the process of logic that they used was they had some testimony that it looked like the wound occurred at about 210, when the President was behind the sign, and that is marked on this little set of keys up at the top.

And then the process of logic continued by saying ''We think that--we know from the measurements that the car was behind the general body of the tree shortly before that.''

And they felt that that was a less likely time for the assassin to have fired, although there is a gap that they commented on themselves in the foliage of the tree that occurs at about 186. And I think those were the two key bits of testimony.

I am not certain that that is all of the testimony. But I thnik that is basically why they concluded that.

And as I mentioned before, I am not aware that they did any of this kind of analysis, nor did they look very seriously, I believe, at the early frames. And in fact if you look in your Warren volumes, they start the Zapruda sequence, it was something like 177 or somewheres in the 170s. So that everything before here isn't even in the final volume that was published.

Mr. Dodd. Well, based on what you have been telling us here, it would seem to indicate that we place the first shot in about eight frames, at least eight frames earlier than that, around 200, 202.

Dr. Hartmann. I thnk a shot probably even before that. If I went through the little mathematical exercise of subtracting a reasonable number of frames from the reaction time, from this cluster, the answer that I got was a shot something like 179 to 195.

Mr. Dodd. To your knowledge, placing the presidential limousine and being in the Book Depository, where is that tree in that frame?

Dr. Hartmann. You would be looking through the tree. Although as I mentioned there is a break in the foliage at 186. And I made kind of a quick comparison of some of the photographs that were in the Warren volume, and the foliage measurements were made on the basis of the tests that were conducted the next spring.

And the point has been made, and I am--the point has been made in some of the literature, and I am inclined to believe it after looking at the pictures that were taken on 27 November and the pictures that were taken next spring, that there was probably less foliage on the tree on November 22. So that if anything the marksman might have had a larger opening at 186.

So I am inclined not to think that that is a fatal objection to a shot having been made at this time and hitting the target.

Mr. Dodd. In response to Judge Preyer's questions with regard to the number of shots, possible number of shots--and I realize that you are not advocating that this jiggle test is necessarily the best way to corroborate that----

Dr. Hartmann. No, I am not.

Mr. Dodd. But to make the point, Dr. Barger indicated that two of ths shots could have occurred within five-tenths of a second of each other. And I presume what you are telling me is that it would be impossible, based on jiggle analysis, to determine whether or not there was one or two shots within that short a frame, a time-frame.

Dr. Hartmann. I think it would be very difficult to tell. You see the kind of problem that you would get into, if we just take any of this pattern of jiggle back here towards the end of the diagram, it would be hard to pick two of those spikes out and say those are related to these two noises. So I don't know what the evidence would be.

Mr. Dodd. Thank you. Thank you, Mr. Chairman.

The Chairman. Mr. Fithian, anything further?

Mr. Fithian. Nothing, Mr. Chairman.

The Chairman. Okay. Dr. Hartmann, under the rules of our committee any witness at the conclusion of his testimony may have five minutes in which to expand upon his testimony before the committee in any way. I would like to extend to you five minutes if you so desire.

Dr. Hartmann. Just to make the point very briefly that it has occurred to me that perhaps sometimes a scientist making the measurements of these films comes across as very cold-hearted. I comment at least for myself, and I think many of us, that the horror of this thing came across many, many times in doing this. And I wish you all very much good wishes to clarify what really has happened here.

Thank you.

The Chairman. Thank you very much, sir.

There being nothing further, these hearings are adjourned to nine a.m. tomorrow morning.

[Whereupon at 6:15 p.m. the hearings were adjourned to reconvene at 9:00 a.m., Tuesday, September 12, 1978.]

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